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AVOCADO TREE, FREEHOLD, COSTA RICA.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 77.
B. T. GALLOWAY, *Chief of Bureau.*

THE AVOCADO,

A SALAD FRUIT FROM THE TROPICS.

BY

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BOTANICAL INVESTIGATIONS AND EXPERIMENTS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 3, 1904.

Sir: I have the honor to transmit herewith the manuscript of a technical paper entitled "The Avocado, a Salad Fruit from the Tropics," and to recommend its publication as Bulletin No. 77 of the series of this Bureau. This paper was prepared by Mr. G. N. Collins, Assistant Botanist in Investigations in Tropical Agriculture, and has been submitted by the Botanist with a view to publication.

The eight half-tone illustrations are considered necessary to a complete understanding of the text of this bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The avocado is a tree native in Central and South America, where it has been cultivated by the aborigines since very ancient times. The large and usually pear-shaped fruit is not used as a fruit in the popular sense of that word, but as a salad. It is highly prized by those familiar with it in the American Tropics, and as its nature comes to be more widely understood in the United States its popularity increases. There is now a regular demand for it in our large cities. The long journey which the avocado must make between producer and northern consumer renders important the question of shipping qualities. But one type is known in Porto Rico, and this will not withstand shipment to New York except in cold storage.

While accompanying Mr. O. F. Cook, of this Department, on expeditions to Mexico, Central America, and the West Indies for the study of coffee, rubber, and other tropical cultures, Mr. Collins has found that the varieties of the avocado are much more numerous and diverse than was hitherto supposed. In developing the culture of avocados it is important that these varieties be canvassed to secure the best types. Of particular interest are the remarkably thick-skinned avocados of Guatemala, which thus far appear to have escaped notice. These varieties promise to withstand shipment much better than any of the thin-skinned forms now cultivated, and their introduction into Porto Rico will, it is hoped, aid materially in establishing a profitable industry in that island.

Mr. Collins's report contains much information, acquired under his exceptionally favorable opportunities for observing the avocado, which will be useful to those interested in the culture, transportation, and marketing of this salad fruit.

FREDERICK V. COVILLE,
Botanist.

OFFICE OF BOTANICAL INVESTIGATIONS AND EXPERIMENTS,
Washington, D. C., September 30, 1904.

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THE AVOCADO, A SALAD FRUIT FROM THE TROPICS.

INTRODUCTION.

As our contact with the Tropics becomes more and more intimate, and transportation facilities are improved, the number of fresh food products received from tropical countries is rapidly increasing. Among the most promising of such articles is the avocado, still little known, but rapidly increasing in favor.

The avocado, though technically a fruit and usually referred to as such, is from the culinary standpoint no more a fruit than the cucumber. It is more accurately described by the term "salad fruit," and may be said to stand alone as the only fruit that when ripe is eaten almost exclusively as a salad. The nearest approach to this is perhaps the olive, which is eaten more as a relish. This unexpected rôle no doubt accounts to a large extent for the dislike or indifference often professed by persons tasting the avocado for the first time. As in the case of the olive, where the novice usually describes the fruit as an insipid pickle, the appearance of the avocado leads one to expect a sweet or acid fruit, and the more or less unconscious disappointment usually leads the experimenter to pronounce the avocado tasteless and oily. One writer describes it as having a "taste not much like that of our pears [the avocado is often called 'alligator pear'], and in first trying to eat the fruit one may pronounce it a poor pear but a good kind of pumpkin," and adds the charitable suggestion that "cooking or preserving may bring out the hidden virtues."

Few persons who live for any length of time in countries where avocados are to be had fail to acquire a taste for this delicious salad fruit. It is the rule, however, that the taste for an entirely new article of diet has to be cultivated, and a food which was unknown to our fathers and which we meet for the first time after our tastes have been formed is seldom accepted at the first trial. In most cases it is only after repeated attempts, prompted usually by the assurances of the initiated, that a fondness for the strange article begins to grow. The human taste is, however, fairly uniform, and a liking for any food

that is popular in its native country is usually acquired by the stranger if his first attempts do not create a prejudice so strong as to prevent further experiments. As examples of foods that when first tried outside of their native country were by most people either disliked or considered insipid but which have since become firmly established may be mentioned olives, bananas, artichokes, chocolate, tomatoes, curries, and peppers.

With avocados the taste is usually acquired after two or three attempts, and many profess a fondness for the fruit at the first trial. That the taste when once acquired amounts almost to a craving is attested by prices paid for the fruit in the northern markets, where 15 cents each is about the lowest figure at which they can be bought, and good fruit usually sells as high as 30 cents, though 50 or 60 cents is not an uncommon price. The avocado may thus be said to have taken the first steps along the lines by which most foreign fruits have been successfully introduced.

An early impetus was received when the fruit was served on the tables of the rich and fashionable, its intrinsic merit being aided, without doubt, by the desire to inaugurate a novelty at once rare and expensive. The tendency to imitate this use assisted in increasing the demand until the fashionable hotels were able to score a point by adding the fruit to their menus. From this stage to that of introduction into the markets and fruit stores, where the general public will make its acquaintance, is, perhaps, the slowest and most crucial step in the history of a successful new product, and one that the avocado is at present undergoing.

ORIGIN AND HISTORY.

EARLY ACCOUNTS.

What appears to be the earliest reference to the avocado is found in Oviedo's report to Charles V of Spain, in the year 1526,[a] a translation of which follows:

> On the mainland are certain trees that are called pear trees (perales). They are not pear trees like those of Spain, but are held in no less esteem; rather does this fruit have many advantages over the pears of that country. These are certain large trees, with long narrow leaves similar to the laurel, but larger and more green. This tree produces certain pears, many of which weigh more than a pound, and some less: but usually a pound, a little more or less, and the color and shape is that of true pears, and the skin is somewhat thicker, but softer, and in the middle it holds a seed like a peeled chestnut; but it is very bitter, as was said farther back of the mammee, except that here it is of one piece and in the mammee of three, but it is similarly bitter and of the same form; and over this seed is a delicate membrane, and between it and the primary

[a] Sumario de la Natural Historia de las Indias. (Biblioteca de Autores Españoles, Historiadores Primitivos de Indias, Madrid, 1852. 1: 502.)

skin is that which is eaten, which is something of a liquid or paste that is very similar to butter and a very good food and of good flavor, and such that those that can have them guard and appreciate them; and they are wild trees in the manner that all those that have been spoken of, for the chief gardener is God, and the Indians apply no work whatever to these trees. With cheese these pears taste very well, and they are gathered early, before they are ripe, and stored; and after they are collected they mature and become in perfect condition to be eaten; but after they are ready to be eaten they spoil if they are left and allowed to pass that time.

A more complete discussion appears in the same author's History of the Indies,[a] written some time after his original report, where he adds that some years after his report to Charles V "I saw many of these pear trees in the province of Nicaragua, placed by hand in the lands and yards or gardens of the Indians and cultivated by them. And some of these trees are as large as walnut trees, but the pears are smaller than those of Cueva." The locality referred to in his first account is the northern part of Colombia, near the Isthmus of Panama. The fruit described would seem to resemble some of the poorer varieties common in southern Mexico, or the Costa Rican fruit known as "yas," referred to *Persea frigida* Linden. (See Pl. VIII.) The fruit must have been of good size and the seed very large, for without knowing the size of the "vinous pears of Spain," to which the fruit is compared, the weight is said to be about a pound, while the flesh is said to be the thickness of a goose quill.

Cieza de Leon[b] refers to the avocado as one of the native fruits eaten by the Spaniards of Panama (p. 16), and as one of the foods of the natives of Arma and Cali, Colombia (pp. 72–99). It would seem that the fruit was of considerable importance, as it is one of the very few kinds of which particular mention is made. The fruit described is said to have the pulp about the thickness of a finger.

Hernandez[c] describes the avocado in Mexico under the Aztec name "ahuacaquahuitl." There is also a long description of both the fruit and the tree in Ulloa's Voyage to South America (1736).

The first authentic reference thus far found to the avocado in the West Indies is made by Hughes.[d]

COMMON NAMES.

The various common names of the avocado form a curious and undignified jumble. None seems to be available that is not either misleading in its application or difficult to pronounce.

The most common designation among English-speaking people is

[a] Oviedo, 1851, Historia General y Natural de las Indias, 1: 353.

[b] The Travels of Pedro de Cieza de Leon [1532–1550], Hakluyt Society, 1864.

[c] Hernandez, F., 1651, Rerum Medic. Nov. Hisp. Thes., 89.

[d] Hughes, W., 1672, The American Physitian, 40.

"alligator pear," and, although it is very difficult and for many reasons undesirable to change a popular name, it seems best while this fruit is still little known to endeavor to secure a less misleading designation. The name "avocado" is almost as widely used as "alligator pear," and, while not altogether unobjectionable, its adoption will avoid the confusion of this salad fruit with varieties of the common pear. The use of the name "alligator pear" not only retards the true appreciation of this very distinct article of diet, but will eventually cause annoying complications in statistical classifications of the products of regions where both this and true pears are grown. The word "pear" is sometimes appended to "avocado," and the name is then no less objectionable than the other form.

"Palta" is applied to the avocado in Chile, Peru, and Ecuador, and is said by Garcilasso de la Vega [a] to have been applied by the Incas, who brought this fruit from the province of that name to the warm valley of Cuzco, although it seems not improbable that the province may have received its name from the tree, according to the common custom of primitive people.

The name "ahuacaquahuitl," given by Hernandez, signifies "like the oak tree," and is variously spelled by other writers.

The words "aguacate" and "avocado" are probably Spanish spellings of attempts to pronounce the Aztec name. To an Andalusian the sound of the word would naturally suggest the spelling "aguacate," while a Castilian would be more likely to adopt the other form.

The French name "avocat" is probably a modification of the Spanish, or perhaps an independent approximation of the native name.

The tendency to transform a new name into a word already existing in the language is shown in the spelling "abogado" in the Spanish and "avocat" in the French, both words meaning lawyer.

Tussac [b] gives "aoucate" as the Carib name and derives the French "avocat" from that form. Jumelle and Pickering also give modifications of this word as Carib. It seems impossible that the Carib and Aztec names should be so similar, and it is more likely that the Carib's attempt to pronounce the Spanish designation was erroneously recorded as a native name.

The form of the fruit obviously suggests the term "pear," and "perales," or pear trees, was the name under which they were first recorded by Oviedo in 1526, that author, however, stating that they were pears in form and in nothing else.

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[a] Garcilasso de la Vega, Ynca, 1605, Royal Commentaries of the Yncas, Hakluyt. ed., 2 : 335.

[b] Tussac, F. R. de, 1824, Flore des Antilles, 3 : 15.

The name "alligator" is entirely without warrant, and no one has as yet suggested even a fanciful application to any of the characteristics of the fruit or tree. It has been suggested that the term is a further corruption of the Spanish "aguacate," and this must be admitted as possible. The occurrence of the word "alligator" prefixed to the names of plants, such as "alligator pepper" for *Amomum melegueta* Rosc., suggests that the word may formerly have been used to signify false or worthless, and if this were true its application to this pear-shaped fruit would be very natural.[a]

The application of other English names, such as "subaltern's butter," "midshipman's butter," "vegetable marrow," etc., is obvious.

Below is a partial list of the names and spellings that have been applied by different writers:

Popular names of the avocado.

Name.	Country.	Language.	Authority.
Abacate	Brazil	English	Orton, p. 5.
Aguacate		Spanish	
Aguacatillo	Mexico		Ramirez, p. 3.
Agualate		Spanish	Velasquez Dict.
Ahoacaquahuitl	Mexico		Ramirez, p. 3.
Ahuaca	do	Aztec	Jumelle, p. 179.
Ahuacahuitl		do	Markham, in Cieza de Leon p. 16.
Ahuacalt		do	Sagot, p. 196.
Ahuacaquahuitl	Mexico	do	Hernandez, p. 89.
Ahuacate	Peru	Spanish	Velasco, I, p. 63.
Albecato pear	Jamaica	English	Sloane, II, p. 133.
Alligator pear		do	
Aouaca		Carib	Jumelle, p. 179.
Aouacate	Antilles	do	Tussac, p. 15.
Avicato		English	Knox, p. 222.
Avigato	Barbados	do	Hughes, G., p. 130.
Avoca	Mauritius		Lequat, II, p. 201.
Avocado		Spanish and English	
Avocadobirne		German	Semler, II, p. 454.
Avocado pear	British West Indies.	English	Bois, Rev. Hort., 1900, p. 546
Avocat		French	Jumelle, p. 179.
Avocato			P. Brown, p. 214.
Avogato pear		English	Dampier, p. 203.
Butter pear		do	
Cupanda	Tabasco, Mexico		Ramirez, p. 21.
Cupandra	Mexico		Do.
Cura	South America		Amador, in Oviedo, p. 353.
Custard apple	West Africa	English	
Laurell peach			Parkinson, p. 1514.
Mantequilla silvestre	Mexico	Spanish	Semler, IV, p. 264.
Midshipman's butter		English	Smith, Treasury of Botany.
Nicaraguae pomum		Latin	Chambrey, p. 586.
On	Yucatan	Maya	Ramirez, p. 138.
Palta	Peru		Cieza de Leon, p. 73.
Patta	Peru and Mexico		Lunan, p. 38.
Peral de abogado		Spanish	Jacquin, p. 38.
Peras	Colombia	do	Oviedo, p. 353.
Sabaca			Lunan, p. 38.
Shell pear	Jamaica	English	Hughes, W., p. 40.
Spanish pear	do	do	Do.
Subaltern's butter			Marayat.
Tonalahuate	Morelos, Mexico		Ramirez, p. 70.
Vegetable marrow		English	Smith, Treasury of Botany

[a] Other instances of the use of this word that admit of this interpretation are alligator apple (*Anona palustris* L.) and alligator crocodile (*Osteolaemus tetraspes*). The word "alligator" is said to be derived from the Spanish *El Lagarto*, meaning "the lizard." The expression "alligator tears" or "crocodile tears" can also be interpreted in the same way.

NOT NATIVE IN THE WEST INDIES.

Many general works on tropical agriculture refer to the avocado as a native of the West Indies. There seems, however, to be no positive warrant for this, while there are many indications to the contrary. De Candolle [a] states that it has been found wild in this region, but the authority cited [b] says simply "American Tropics," and his records of the different varieties occurring in the West Indies evidently refer to cultivated forms. A wild species of Persea, *P. sylvestris*, is reported from Cuba, but this is quite distinct from the avocado, and is called by the Cubans "aguacate silvestre." The statement "in insula S. Dominici" occurs in Bauhin's description of the avocado.[c] Acosta is cited, however, and this author gives no reference to the fruit in that locality.

The avocado was certainly not common nor was it cultivated in the West Indies before the time of Columbus, for of the early writers consulted none makes mention of it as native in that locality, although references to it in Colombia, Ecuador, and Peru are frequent. It is significant that Oviedo entitles his discussion "De los perales salvajes de la Tierra-Firma," or "Wild pear trees of the mainland," and does not mention their occurrence on the islands, as he does in the case of so many other plants. This part of his history was apparently written while in Santo Domingo, and his knowledge of that island is so circumstantial as to make it very improbable that he could have remained ignorant of its existence there, and while less conversant with the remainder of the West Indies he makes mention of many comparatively obscure plants as existing in "other islands;" all of which seems to indicate that the avocado was unknown in the Spanish settlements of the West Indies in the early part of the sixteenth century.

Hughes,[d] Dampier,[e] and Hans Sloane [f] refer to the avocado as planted in Jamaica by the Spaniards. Brown [g] definitely states that the tree was introduced into Jamaica, and Jacquin [h] says the same of the West Indies as a whole. Tussac [i] also affirms that the avocado is not a native of the West Indies, although he gives a Carib name for the plant.

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[a] De Candolle, 1885, Origin of Cultivated Plants, 292.

[b] Meissner, 1864, in De Candolle, Prodromus, 15 : 1 : 53.

[c] Bauhin, Caspar, 1623, Theatri Botanici, 439.

[d] Hughes, W., 1672, The American Physitian, 41.

[e] Dampier, William, 1703, A New Voyage Around the World, 1 : 202.

[f] Sloane, Hans, 1725, Natural History of Jamaica, 2 : 133.

[g] Brown, P., 1789, History of Jamaica, 214.

[h] Jacquin, J. N., 1764, Observ. Botanic, 1 : 38.

[i] Tussac, F. R. de, 1824, Flore des Antilles, 3 : 15.

DISTRIBUTION.

The avocado has, since the time of Columbus, spread from its home in America entirely around the Tropics. That such an important food plant was confined to the American continent until the post-Columbian contact with the Old World, while numerous other plants, such as the yam, taro, and sweet potato, had already spread to parts of the Old World, was probably due to the fact that the avocado will not easily survive long voyages, while most of the tropical root crops have much greater vitality.

The fruit spread but slowly before the last century, but in recent times its culture has rapidly increased, and it is now cultivated in most of the countries that are suited to its growth. It has been cultivated in India since about 1860, and has reached the islands of Madagascar, Reunion, Madeira, the Canaries, Samoa, and Tahiti. In Natal and Australia it is just gaining a foothold. Its cultivation is increasing in Algiers. In 1882 it was reported as growing in southern France along the shores of the Mediterranean. Some of the trees had flowered, but apparently none had fruited at that time. In southern Spain, however, the tree fruits, and is cultivated to a limited extent.

E. Roul [a] gives the range of this species as 36° from the equator. He states, however, that certain varieties, such as "dulce," are not found outside the Tropics.

The avocado seems to have commanded very little attention in the West Indies. No mention is made of this fruit in Morris's account of the British West Indies, and the index to the bulletins of the botanical department of Jamaica does not contain a single reference to it. In Porto Rico the fruit is abundant and popular, although not so important a staple as in tropical Mexico, where quantities of even the most inferior fruit are consumed by the natives, who consider it an important ingredient of that indispensable Spanish dish, soup.

There are now orchards of avocados in southern Florida and California, and a slightly hardier variety would greatly extend the culture of this fruit in these regions.

Cuban fruit is shipped to the northern markets, and the conditions in that island are probably similar to those existing in Porto Rico.

In the tropical parts of Mexico, Central America, and South America the fruit is very common, and its different forms and races are innumerable.

DESCRIPTION.

The avocado tree is 20 to 60 feet high, varying in habit from tall and rather strict to short and spreading. In favorable situations the

[a] Sagot, P., Manuel Pratique des Cultures Tropicales, 198, 1893.

top is very dense. The leaves are 20 to 40 cm. long and 7 to 25 cm. wide, acuminate at the apex, varying from acute to truncate at base, petiole 2 to 8 cm. long. The upper surface is smooth, with depressed veins; the lower surface is glaucous, with the raised veins slightly pubescent. Different forms, all referred to the one species, vary so greatly in the form and size of the leaves that close relationship would hardly be suspected. Climatic differences may possibly account for some of this variation, the large, broad-leaved forms being usually found near the coast. Young trees have also, as a rule, much larger leaves.

The flowers are perfect and are borne on loose axillary racemes near the ends of the branches, usually at the base of the year's growth. The corolla is wanting, the calyx 6-parted. The lobes are all of equal length, green in color, and pubescent. The stamens are 9, in three series; the anthers 4-celled, opening by valves hinged distally. The two outer series have the openings introrsely directed; the inner series has the two distal valves introrsely, the basal pair extrorsely, directed. Each stamen of the inner series bears near its base two large glands. Inside the stamens are three staminoidia. Occasionally 4-parted flowers are to be found, in which case they are 4-parted throughout. The ovary is 1-celled, the style simple.

The fruit in some varieties is long and slender; in others, nearly globular, varying from 3 to 15 cm. (1 to 6 inches) in diameter. The outside covering in some forms is soft and pliable, often less than one-half millimeter in thickness, while in others it is hard and granular, in some of the Central American forms reaching 3 mm. in thickness. The fleshy part of the fruit between the skin and the seed varies greatly in thickness, but is always butyraceous in consistency, though in some cases much firmer than in others. In the better varieties the fibrovascular system that enters the fruit from the stem is discernible only in the thin flesh at the very base of the fruit and at the base of the seed, which is toward the apical end of the fruit. The seed thus appears to receive its nourishment directly from the pulp by absorption or ceases to receive nourishment before the fruit is fully formed. In the coarser forms the bundles can be traced from the stem throughout the pulp to the point where they enter the seed, and in some cases they are so prominent that the quality of the fruit is seriously impaired.

The tree is usually described as evergreen. In some localities, however, the leaves are dropped just before flowering, leaving the tree naked for a short time. This is the case in Alta Vera Paz, Guatemala, where a type with narrow leaves and very thick-skinned fruit prevails. Whether this deciduous character is peculiar to the variety or the result of climatic conditions could not be determined.

The seed is single, inverted, exalbuminous, spherical, or pointed, provided with two more or less distinct coats, one or both of which may adhere very closely to the cotyledons, though usually separable at the base of the seed; or they may adhere to the flesh of the fruit and separate from the cotyledons. This latter condition is observed more commonly in specimens not fully matured. The surface of the outer coverings may be coarsely reticulated or granular. The seed coats are frequently produced into a point beyond the apex of the cotyledons. The cotyledons are nearly hemispherical in form, white or light green in color. The surface of some forms is smooth; in others rugose. The plumule is well developed before the fruit ripens and is located from 10 to 15 mm. from base of seed. Concerning the seedling, Holm[a] has pointed out that no hypocotyl develops. He also calls attention to the curious fact that the first four leaves are opposite and by showing a differentiation into petiole and blade more closely resemble the mature leaf than do the following five or six leaves, which are almost scalelike.

BOTANICAL AFFINITIES.

The genus Persea, to which the avocado belongs, is a member of the family Lauraceæ. Among the other more important economic members of the family are cinnamon (*Cinnamomum cinnamomum* (L.) Cockerell), camphor (*Cinnamomum camphora* (L.) Nees), and sassafras (*Sassafras sassafras* (L.) Karst.). With the exception of cinnamon, they are used chiefly in medicine. The avocado is the only member of the family cultivated for its edible fruit.

Mez, in his monograph of the family,[b] describes forty-seven species of Persea, and states that the genus is confined to the American continent, with the exception of one species in the Canary Islands.

On the contrary, F. Pax[c] restricts the genus to ten species, only one of which, *P. persea* (L.) Cockerell (*P. gratissima* of Pax), belongs in America. No intimation is given as to the disposition of the other American species. This latter author divides the genus into two sections—Eupersea, with the one species *P. persea*, and Alseodaphne, with nine Old World species, five of which are imperfectly known.

It is almost impossible to come to any satisfactory conclusion in regard to the systematic relationships of the various forms of avocados, for the present classification of this group is based almost

[a] Bot. Gaz., July, 1899, p. 60.

[b] Mez, Carolus, 1889, Lauraceæ Americanæ, Jahrb., Königl.-bot. Gart., 5: 135.

[c] Engler and Prantl, Die Natürlichen Pflanzenfamilien, 1889, 3: 2: 114–115.

entirely on floral and foliage characters, and in most cases it is impossible to secure flowers or leaves from the individual trees which produced the different fruits. This is especially the case with fruits collected in the markets, but even where the fruit is collected from the trees no flowers will be present at the time the fruit is mature, and complete material can only be secured by residents or by repeated visits to the same locality at different seasons.

On the other hand, out of the forty-seven species described by Mez twenty-six have the fruit unknown, and in the two varieties distinguished from the typical *P. persea* no mention is made of the fruit.

The diagnostic characters of the species as shown in this author's key to species are:

Anthers of the three outer series fertile, 4-locellate; ovary pilose; perianth-lobes equal or subequal; filaments two and one-half to three times as long as the anthers; staminodes twice as long as the stipe.

With regard to leaf characters, it is difficult to draw definite conclusions, as the characters of the leaves vary greatly at different stages of the tree's development.

VARIETIES.

The botanical descriptions of varieties of the avocado are in nearly every case too meager and too general in their terms to be recognized and are in every case based on floral and leaf characters, no mention being made of the fruit. Meissner [a] describes four varieties, as follows:

Var. *vulgaris*. Leaves medium sized, mostly 3 to 4 inches long, 1½ inches broad, oval or obovate; flowers short pediceled. West Indies, Central and South America.

Var. *oblonga*. Leaves long, equally attenuate at both ends, often acute, 4 to 9 inches long, 1¼ to 2 inches wide, short pediceled. West Indies, Mexico, Peru, Brazil, Mascarene Islands, Java.

Var. *macrophylla*. Leaves larger, 6 to 9 inches long, 3 to 4½ inches broad, obovate or obovate-oblong, acutely acuminate, short pediciled. Eastern Peru, British Guiana, Central America, Mexico.

Var. *schiedeana*. Leaves ample, 9 inches and over in length, 3 to 4½ inches broad, obovate and oblong, acute or obtuse, young leaves with a thick yellow tomentum, veins and veinules rather accentuated underneath, panicles terminal, bases with long persistent imbricate bracts, pedicels rather long. Misantla, Mexico.

Mez [b] recognizes two varieties as differing from the normal type, one of which is the *schiedeana* described above and which is apparently confined to Mexico; the other, *drimyfolia*, also confined to

[a] Meissner, in De Candolle, Prodromus, 15:1:53.

[b] Mez, Carolus, 1889, Lauraceæ Americanæ, Jahrb., Königl.-bot. Gart., 5:147.

Mexico, was formerly considered a distinct species. A translation of his description of the latter variety is as follows:

Variety *drimyfolia.*

Differs from the normal form in being smoother; leaves oblong-lanceolate, narrowly acute at base, apex acute or somewhat acute, below glaucous.

A delicious fruit tree, cultivated in tropical regions, and from thence imported into Europe. In Portugal and Sicily it winters if protected, and sometimes produces mature fruit. Embryo (according to Schomburgk) often with 3 cotyledons, and frequently germinating on the tree. According to Krug, the fruits of this tree come true to seed, and it is not necessary to graft.

This description applies best to the hard-skinned types of Guatemala, the peculiarities of the fruit of which seem never to have found their way into literature, and it is probable that the similarity is confined merely to the dimensions of the leaves.

The marked differences in the fruits of the avocados from different localities are recognizable in the earliest descriptions. Hernandez's description of a black fruit the size and shape of an egg or fig corresponds well with many of the small black forms grown in Mexico at the present time and, so far as known, not occurring elsewhere. On the other hand, all the early writers on the West Indies describe a much larger fruit with much thicker flesh.

The distinction between the thick-skinned and thin-skinned forms of the avocados was made as early as 1590 by Acosta,[a] who wrote:

The Palta is a great tree, and carries a faire leafe, which hath a fruite like to great peares: within it hath a great stone, and all the rest is soft meate, so as when they are full ripe, they are, as it were, butter, and have a delicate taste. In Peru the Paltas are great, and have a very hard skale, which may be taken off whole. The fruite is most usual in Mexico, having a thinne skinne, which may be peeled like an apple: they hold it for a holesome meate, and, as I have said, it declines a little from heat.

It is worthy of note that the earliest account of the avocado in the West Indies, by Hughes,[b] describes a hard-skinned type, yet so far as known this type does not exist in the West Indies at the present time. The description referred to follows:

This is a reasonable high and well-spread Tree, whose leaves are smooth, and of a pale green colour: the Fruit is of the fashion of a Fig, but very smooth on the outside, and as big in bulk as a Slipper-Pear; of a brown colour, having a stone in the middle as big as an Apricock, but round, hard and smooth; the outer paring or rinde is, as it were, a kinde of a shell, almost like an Acorn-shell, but not altogether so tough; yet the middle substance (I mean between the stone and the paring, or outer crusty rinde) is very soft and tender, almost as soft as the pulp of a Pippin not over-roasted.

It groweth in divers places in Jamaica; and the truth is, I never saw it elsewhere: but it is possible it may be in other Islands adjacent, which are not much different in Latitude.

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[a] History of the Indies, Hakluyt Society ed., 1: 250.

[b] Hughes, W., 1672, The American Physitian, 40–42.

I never heard it called by any other name then the Spanish Pear, or by some the Shell-Pear; and I suppose it is so called only by the English (knowing no other name for it) because it was there planted by Spaniards before our Countrymen had any being there; or else because it hath a kinde of shell or crusty out-side.

I think it to be one of the most rare and most pleasant Fruits in that Island: it nourisheth and strengtheneth the body, corroborating the vital spirits, and procuring lust exceedingly: the Pulp being taken out and macerated in some convenient thing, and eaten with a little Vinegar and Pepper, or several other ways, is very delicious meat.

GEOGRAPHICAL TYPES.

In nearly all parts of the American Tropics there is great variety in the forms of the avocado, yet comparatively few have received distinctive names, and only a very few have found their way into literature. In the Revue Horticole, 1900, page 546, D. Bois describes nine Mexican varieties as follows:

Dulce largo, green, in form of a gourd, with a long neck; seed large.
De tecosautla, dark green, with ovoid seed.
Pagua, large, spherical, purple in color, with a large seed.
Morado de Chalco, pear-shaped, purplish.
Dulce, large, green, oblong, with whitish, ovoid seed.
Pagua redonda, round, green, with a very large reddish seed.
Verde de San Angel, light purplish, pear-shaped.
Morado de San Angel, light purple; seed ovoid.
Verde chico, small, green, with an elliptical seed.

These same varieties appear in slightly different form in Sagot's Manuel Pratique des Cultures Tropicales, page 157.

Sagra [a] mentions four forms from Cuba, as follows:

Violet, almost round.
Thick green, round, with yellowish flesh of a spongy consistency.
Long yellow, similar to a large pear.
Long green.

There is little to be gained in attempting to identify these forms, as none of the characteristics of economic importance are mentioned, and from observations made in Mexico it appears probable that these forms merge into one another with many imperceptible gradations.

The author has had the opportunity of studying avocados in Porto Rico, Guatemala, Costa Rica, and Mexico; and from the fruit that has come under observation the avocados of Mexico, while diverse in form and color, seem to be much more closely related to each other than to those of any other of the above-mentioned countries.

As much of the fruit was obtained in markets, it was often impossible to determine the character of the tree on which any particu-

[a] Sagra, Ramon de la, Historia Fisica Politica y Natural de la Isla de Cuba, 11: 186, 1863.

lar fruit was borne, and in no case could floral and fruit characters be compared. Aside from yield, vigor, and hardiness, however, the more important characteristics of a variety, from a commercial standpoint, can be determined from the fruit alone.

In a general way each of the countries visited exhibited distinct types of avocados, although in nearly every case aberrant forms occur which frequently seem to be associated with the types of other countries. In many such cases the resemblance is probably a similarity in formal characters rather than a true relationship.

In making the following descriptions, several new characters have been used, such as the nature of the skin, whether it is hard or soft, thick or thin, and the character of the seed coats, believing that these are of more importance than the form and color by which the cultivated varieties have usually been distinguished.

Until more complete botanical studies have been made it seems advisable in describing the different forms to take them up by countries. The names applied to the different forms are merely to facilitate reference. It seems a curious fact that although the avocado has a great variety of names in different countries the different forms in any particular locality rarely receive distinctive appellations. Thus in Porto Rico, where mangoes that to the casual observer appear identical are carefully distinguished and provided with particular names, the many varied forms of avocados are all called "aguacate" without further distinction. In Mexico also, where the variety is still greater, no names for the different forms could be elicited from those selling the fruits in the markets, although the qualities of the different forms were keenly appreciated and willingly pointed out.

As might be expected, there are several countries that claim to produce the finest avocados, among which may be mentioned Colombia, Hawaii, Peru, and Brazil. According to travelers familiar with the Pacific coast of tropical America, the largest and finest avocados come from the vicinity of Tamaco, in Colombia. These are said to be much larger than those of the Central American coast and of equally fine flavor.

In Brazil the finest fruits are said to come from the islands of Marajo, at the mouth of the Amazon.

As with most fruits, the largest and fairest are not always the best flavored. The delicate nutty flavor of some of the small thin-fleshed kinds of Guatemala is seldom equaled in the large thick-fleshed varieties.

GUATEMALA.

The avocados of Guatemala form a very distinct group. They are at once the most marked and, from a commercial standpoint, the most promising type for introduction into our tropical possessions.

The most peculiar characteristic of the Guatemalan avocados is the unusual texture of the skin. Unlike the Mexican and West Indian types, which are those usually found in our northern markets, the Guatemalan fruit is covered with a skin so thick and unyielding that it suggests the shell of a nut. If pressed inward with the finger, instead of bending or tearing, the skin breaks with a granular fracture.

To judge from Acosta's account, the avocados of Peru have a skin similar to those in Guatemala, though, curiously enough, in Costa Rica, midway between these two countries, not a single hard-skinned form was observed. In all the Guatemalan varieties the seed coats adhere closely to each other and to the cotyledons over nearly the entire surface. In this respect they resemble the Mexican and differ from the Cuban and Porto Rican forms, which have the seed coats distinct from each other, the outer coat usually adhering to the flesh. The flesh of the Guatemalan forms frequently contains objectionable fibers, but in many cases it is entirely fiberless. In every case the line of division between the flesh and the skin is distinct, and the flesh can be scooped out with a spoon and the skin scraped, agreeing in this regard with the Cuban forms and differing from those of Mexico and Porto Rico, where there is no marked line between the flesh and the skin, and where, if care be not taken in using the spoon, portions of the skin are taken up with the flesh. Fruit of this type is borne on the tall, spreading trees common in Guatemala. The leaves are narrower and longer than in the West Indian type, about 23 cm. (including the petiole, which is about 2.5 cm.) by 7.5 cm. wide, acuminate at the apex, tapering at the base. Leaves smooth above, with depressed veins; below, the veins are prominent, with numerous fine hairs, and the surface is glaucous, with scattered fine hairs.

Although in a general way belonging to one type, the avocados of Guatemala that came under the writer's observation can be separated into three forms capable of more or less definite delimitation.

Thick-skinned round (Pl. V).—This is the most common type in the eastern part of Guatemala. There is great diversity in size and quality among the specimens included under this form, and some of those found at Guatemala City appear to be distinct, but they are not easily separated by formal characters.

Form nearly spherical; color varying from dark green to dark brown or nearly black; skin hard and unyielding, breaking rather than tearing, never less than 2 mm. in thickness, granular in texture; flesh distinctly differentiated from the skin, often separated from it when fully ripe; seed as broad as or broader than long, rounded at the apex. The two seed coats are so united as to be indistinguishable, and when fully ripe adhere closely to the seed, except at a small area near the base. When the green fruit is opened the seed coats often leave the seed and adhere to the flesh.

The better specimens of this and the following form are probably the most promising for introduction into Porto Rico, owing to the thick skin, good keeping qualities, and fine flavor. In the warm and extremely moist climate of Alta Vera Paz, specimens of this form were in perfect condition two weeks after picking. Specimens sent by mail from Coban to Washington, while overripe on arrival, showed no outward evidence of decay, and were still in condition to withstand rough handling.

Thick-skinned oval (Pl. IV).—This description was drawn up to cover two specimens purchased at different times in the market of Guatemala City.

Form oval or oblong; surface roughened with knobs; skin thick and unyielding, breaking rather than tearing, granular in texture; flesh distinctly differentiated from the skin; seed longer than broad, rounded at the apex, covered when ripe with a mealy substance; coats adhering closely to the seed and separating from the flesh when ripe.

Soft-skinned Guatemalan.—Fruit pyriform; surface slightly roughened, shining, skin thick, soft, and yielding, tearing rather than breaking, distinct from the flesh; flesh free from fibers, firm, not darker near the skin. Seed almost spherical, with the outer coat produced into an acute point; seed coats closely united to each other and to the cotyledons except at the base and apex.

This form can hardly be considered a true Guatemalan type, as it lacks the characteristic hard skin. It resembles the Cuban type in many particulars, but differs from it in having the seed coats adhering closely to the cotyledons over the greater part of the surface and in having the outer seed coat produced beyond the apex of the cotyledons. It more nearly resembles the Costa Rican type.

In Guatemala there are at least two other species of Persea that yield edible fruit. These are known among the Indians of Alta Vera Paz by the names "coyo" and "coyocte." Both are generally considered very inferior fruits, though some prefer the "coyo" to the avocado. In Alta Vera Paz the "coyo" and the avocado flower at about the same time, but the fruit of the "coyo" ripens at least a month earlier, a fact which may lend interest to the species in efforts to extend the season.

In the highlands of central Guatemala the avocado is found in regions that are occasionally subjected to temperatures below freezing. The fruit is of good size and quality, and the thorough exploration of this region offers interesting possibilities in the securing of more hardy forms.

PORTO RICO.

The avocados of Porto Rico (Pl. II), although showing great diversity of form, are apparently very closely related, indicating

possibly that they are the result of a single introduction. Compared with the types of the mainland thus far studied, their affinities seem to lie with Mexican avocados. From these they are distinguished chiefly by the character of the seed, the Porto Rican type having the two seed coats distinct, the outer usually adhering to the flesh, the inner more or less closely attached to the cotyledons. In this respect this type also differs from all the continental forms thus far observed. From the avocados of Costa Rica it is further distinguished by the texture of the skin, which is much thinner and softer than the Costa Rican type. In this latter regard it is still further separated from the Guatemalan avocados with their hard, almost brittle skins. From the Cuban type it is separated by the thinner skin and the fact that the flesh and skin are not sharply differentiated.

Form oval or pyriform, with or without a prolonged neck; color green, usually light; surface shining and almost smooth; skin thin and soft, tearing rather than breaking; flesh not differentiated from the skin; seed spherical, oval, or slightly pointed; the two seed coats entirely distinct, the outer usually clinging to the flesh and the inner to the cotyledons.

One specimen from San José, Costa Rica, seems to correspond closely with the Porto Rican forms, the only difference being a slightly thicker and more distinctly differentiated skin.

MEXICO.

The Mexican varieties show the greatest diversity of form, and also a considerable range of color. With the exception, however, of three special forms to be mentioned later, they seem to intergrade and form a connected series. They are at least much more closely related to each other than they are to those found in other countries.

Although many of the Mexican avocados were of really excellent flavor, none were seen that appeared particularly desirable for introduction.

The following is a general description covering the more characteristic features of the Mexican type:

Form spherical, oval, oblong, or pyriform; color varying from green to almost black; surface shining and almost smooth; skin thin and soft, tearing rather than breaking; flesh not differentiated from the skin; seed spherical, oval, or pointed; the two seed coats closely united and usually attached to the seed over the greater part of its surface.

Tapachula (Pl. III).—This sort was first observed at Tapachula, Chiapas, Mexico, where a single tree was found growing in the park. The same or a very similar variety was afterwards found in Costa Rica.

Form of fruit obovate or slightly pyriform; color bright green; surface shining and with slightly raised points white at the top; skin thin and leathery; flesh but imperfectly differentiated from the skin; seed nearly round. The tree

rather short and spreading. The leaves broadly acuminate, almost transverse at base, the broadest part of the blade usually in the proximal portion.

This is apparently one of the most desirable of the thin-skinned sorts. Fully matured fruit was seen neither in Mexico nor in Costa Rica; consequently the character of the seed coats could not be determined. The Costa Rican specimens, while closely resembling the Mexican tree in the shape of the leaves and habit, as well as in the form and peculiar markings of the fruit, differ in having ovate seeds, while in the Mexican specimen the seeds are nearly round.

Long neck.—Of the two samples included in this description one is from Tapachula; the other was purchased in the Washington market and was probably from Cuba. The resemblance is doubtless confined to formal characters.

Form elongated, with a very long curved neck; color green; surface shining and somewhat wrinkled; skin soft, tearing rather than breaking; flesh distinctly differentiated from the skin; seed decidedly longer than broad, rounded at the apex; seed cavity extending into the neck beyond the apex of the seed; the two seed coats entirely distinct.

The flavor and texture of this form are very good, but it will probably not prove to be a good shipper.

Clingstone.—This most aberrant form was found only once in the City of Mexico. It is so very different from the ordinary avocados that it would seem that it must belong to a distinct species. Nothing was learned, however, concerning the nature of the tree, and the natives classed it with the other "aguacates."

Form elongated; color light green; skin soft and pliable, the surface somewhat shrunken and wrinkled; flesh granular in texture and almost tasteless, adhering closely to the seed; seed narrow and pointed; the two coats, if they exist, can not be separated.

The oddity of this form is its only recommendation.

COSTA RICA.

The avocados of Costa Rica show a greater diversity of color than those of any other country visited by the writer, ranging as they do from almost white to black through various shades of green, red, and purple. There is also a great variety of shapes. Still, with the exception of the "yas" (Pl. VIII),[a] they form a very connected series

[a] In the Tropenpflanzer for September, 1903, C. Werckle refers this fruit to *Persea frigida* Linden, a name of doubtful validity. It is excluded from Mez's Lauraceæ Americanæ and placed among the species whose descriptions were unknown. The statement by Werckle that this species extends beyond the frost line makes it of possible importance for hybridizing, should it be desired to extend the culture of this fruit into subtropical regions.

and are easily distinguished from those of other countries. As a group they may be characterized as follows:

Fruit spherical, pyriform, or gourd-shaped; color green, red, purple, or nearly black; skin rather thick, soft, distinct from the flesh. Seed spherical or with only the outer seed coat produced into a point; seed coats closely united to each other and to the cotyledons over almost the entire surface.

In the market at San José, Costa Rica, one specimen was found that could not be distinguished from the common Porto Rican type except that the skin was somewhat thicker than any observed in Porto Rico. A few samples of a form not elsewhere seen were also found in the same market. These were slender necked, with the seed cavity extending into the neck, the seed was oblong, the skin very thin and not distinct from the flesh, which was slightly darker near the skin. These specimens had a very fine flavor and would be desirable for local consumption; the thin skin, however, would probably prevent their being successfully shipped. Of the ordinary type none was seen that had marked desirable qualities.

CUBA.

The avocados of Cuba are closely related to those of Porto Rico, the principal differences being the thicker skin of the Cuban fruit and the fact that in the Cuban forms the skin is quite distinct from the flesh, which is not darker near the skin. The thicker skin may explain why Cuban fruit reaches New York in better condition than that of Porto Rico.

Fruit pyriform or nearly spherical; surface smooth and shining; skin thick, soft, and yielding, tearing instead of breaking, distinct from the flesh; flesh free from fibers, firm, not darker near the skin. Seed nearly spherical or pointed; seed coats entirely distinct from each other and from the cotyledons. Flavor poor.

Specimens on which this description was based were found in the Washington market and were said to have come from Cuba via New York. The flavor was very insipid, which may have resulted from the fruits having been picked when immature, or to overripeness.

HAWAII.

A series of specimens shipped from Honolulu to New York shows a soft-skinned fruit, in general like the avocados of Costa Rica, but much larger.

Form oval, oblong, or pyriform; color green or purple; nearly smooth, shining; skin soft, of varying thickness; flesh distinctly differentiated from the skin; seed longer than broad, variously shaped; the two seed coats usually united and adhering to the cotyledons, except at the base and apex.

A peculiarity not observed elsewhere is that of maturing several fruits in a cluster. In most countries all the fruits of a cluster, except one, drop when very small.

CULTURE.

The avocado was in all probability planted and more or less cared for by the natives of America before the advent of the Spaniards, for although Oviedo in his first account of the fruit in the northern part of Colombia says that the Indians apply no work to these trees, he later adds that "in the province of Nicaragua they are placed by hand in the gardens of the Indians and cultivated by them." Their culture, however, must have been of the crudest sort, limited probably to the mere planting of the seeds, perhaps of the more desirable kinds, near their houses and affording the young plants some slight protection. Nothing that corresponds to culture in the modern sense was applied to the avocado until the fruit was taken hold of by the planters of Florida.

PROPAGATION BY SEED.

The avocado tree is propagated almost entirely by means of seed, the uniformity of the fruit in many localities indicating that certain forms, at least, come true.

Like most tropical fruits, the seed of the avocado, if dried, will not retain its vitality for any length of time, and should be planted as soon as possible after it is removed from the fruit. If carefully packed so as to conserve the moisture, the seeds can, however, be kept alive long enough to permit of their being sent to any part of the world. A very successful method of accomplishing this is to pack them in slightly moistened charcoal placed in a closed receptacle, such as a wooden or tin box.

It is recommended that the avocado be planted where it is to remain, as the long taproot makes it difficult to transplant. If transplanted when small this will, however, be no great obstacle. The spacing will depend largely on the variety and the location, but should be from 15 to 30 feet.

ASEXUAL PROPAGATION.

The avocado is ordinarily considered a refractory subject for grafting or budding. Grafting is, indeed, seldom practiced, but the practicability of budding is now fully demonstrated. Rolfs[a] gives an account of the methods practiced in Florida, where the matter has

[a] The Avocado in Florida, Bul. 61, Bureau of Plant Industry, U. S. Dept. of Agriculture.

received the most attention. The chief difficulty there is in causing the buds to start after they have taken. It may be that this difficulty is on account of unfavorable climatic conditions, for at the Hope Gardens, in Jamaica, Mr. T. J. Harris, under the direction of Hon. William Fawcett, has budded the avocado in large numbers with the loss of hardly a bud. The operation is successfully performed, not only by experienced hands, but students who are budding for the first time are quite as successful with the avocado as with the orange or other plants which are usually considered easy to bud. Mr. Harris's method is practically the same as that recommended by Rolfs. The only difference that could seem of any importance is that the bud is simply tied with raffia instead of being wrapped with waxed cloth.

Mr. George W. Oliver, of the United States Department of Agriculture, states that the avocado is by no means a difficult plant to bud. A healthy stock is considered by him the prime essential, and this is not often secured in the greenhouses of the North.

If the method of patch-budding with old wood that has been found successful with the mango can be used with the avocado it would greatly facilitate the introduction of desirable varieties.

SOIL.

Like a great many tropical plants, the avocado is less exacting in regard to soil than it is with respect to climatic and other conditions. The drainage and the amount of protection that the soil receives from the heat of the sun are probably the most important factors. Trees can be seen growing in a great variety of soils, but always in localities with good drainage. On the other hand, they are seldom, if ever, found in perfectly open places, with the bare ground around the roots exposed to the sun. The heavy clay soil common in Porto Rico seems well adapted to their culture, provided the trees are placed on ground sufficiently sloping to secure good drainage. The avocado is at present absent from the low, flat lands of the island, and it is extremely doubtful whether it would succeed in such localities.

CLIMATE.

The avocado in its native state is a strictly tropical plant, and none of the varieties thus far recorded is able to stand any but the lightest frosts. Although requiring tropical conditions, it thrives best in a somewhat more moderate climate than the mango, and it will seldom be seen in the extremely hot localities where the mango often luxuriates. This may, however, be due to a lack of sufficient moisture, as well as to the high temperature. On the other hand, the avocado will be found growing at much higher altitudes, and here again it is

not plain whether the reduced temperature or the increased moisture is the determining element.

To be successfully grown, the tree must be planted in protected situations if the locality is at all subject to high winds; for the wood is not strong enough to withstand any severe strain, while the large fruit would, of course, be beaten off by any high wind occurring when it was reaching maturity.

In Guam, according to Mr. W. E. Safford, although repeatedly introduced, the avocado has never succeeded, owing to the hurricanes, which invariably kill the trees that otherwise do well. The injury in this case is due to the excessive rainfall as well as to the high wind, a wet situation being fatal to this plant.

CULTIVATION.

The avocado is seldom regularly cultivated, so that little can be said of it in this connection except in the way of conjecture. The best fruit now produced is probably from trees that receive little or no care. This may, however, be due to the fact that the countries where such fruit is grown possess superior varieties or that the natural conditions are more favorable, and should not be taken as indicating that the fruit can not be improved by cultivation. In Porto Rico the trees in their wild state are such prolific bearers that there seems little to be desired in this direction.

The avocado would probably receive little or no benefit from having the ground about its roots stirred, as it is almost impossible to do this and prevent washing from the severe rains, and it is much better to secure protection from some low-growing plant that will not exhaust the soil. Leguminous plants would doubtless be the most satisfactory, and in Porto Rico there are several that could be so utilized. Some useful plant belonging to this group might serve as a catch crop and at the same time afford the necessary protection to the soil.

In France it has been recommended that grafted plants be grown on fruit walls, in the same manner as citrus trees.

IMPROVEMENT.

If experiments in improving avocados through breeding have been tried the results seem never to have been published. Individual growers must have done more or less selecting, and accounts of their results would doubtless be of considerable value to breeders.

The points to be kept in mind in any attempt to improve the avocado are: (1) Shipping qualities, (2) uniformity, (3) extension of season, (4) seed reduction, (5) texture, (6) flavor, (7) yield, (8) size, (9) resistance to cold.

SHIPPING QUALITIES.

To the growing of avocados in other than subtropical regions there is perhaps no obstacle so great as the difficulty of placing the fruit on the northern markets in good condition. To overcome this, more can be expected from the introduction of new varieties and improved methods of packing and shipping than from any changes brought about by cultural means. Any advance, however, that can be made in the keeping and shipping qualities will be of the greatest importance.

Under the head of varieties are discussed the thick-skinned forms grown in Guatemala, and their introduction into Porto Rico bids fair to be a distinct advance. The improvement of the existing forms in this respect by hybridization and selection is, as with all other characteristics, an untried field. The chief drawback is, of course, the length of time that must elapse before the young plants reach fruiting age. The tree can, however, be grown with little care; and with the experiments carefully outlined, so that the desired results may be kept in view, the trouble and expense would not be great, and in time some really valuable results might be expected.

UNIFORMITY.

With the avocado, as with other fruits, a regular market can only be expected when there is a regular supply of a uniform product. In Porto Rico the fruit varies in form from almost spherical to those that have a long, curved neck. The extremes probably represent distinct wild strains, but the fruit seems to come true to seed to only a limited extent, and anything like perfect uniformity can only be expected with asexually propagated plants. Rolfs[a] shows that the varieties in Florida do not come true to seed.

EXTENSION OF SEASON.

Extension of season is an important desideratum, especially in the direction of later fruiting forms, the desirability of which is considered farther on. Advance in this direction is likely to be made by the introduction of new varieties and, perhaps, by extending the cultivation of the trees to regions of more continuous moisture where the season of flowering can be to some extent controlled. The tree flourishes in many localities where it fails to bear fruit, and, as with the mango, this sterility is usually found in localities of almost continuous humidity. Under such conditions an artificial check, such as

[a] Rolfs, P. H., Bul. 61, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1904.

root pruning, has been found to induce flowering and the setting of fruit. This can easily be overdone, however, in which case the trees will bear one large crop and then die.

Some of the most prolific trees are those grown in rather small depressions of porous rock in southern Florida, where the plants are, in a manner, root-bound, while the porous nature of the rock affords good drainage. There are a number of ways in which the growth may be checked and the yield increased. The baring of the roots to the sun would appear a very satisfactory method. A custom of hacking the trees to make them bear is practiced by the Indians of Mexico. In any case where the fruiting is induced by artificial means the season will be more or less under control.

SEED REDUCTION.

In most forms of avocado the seed forms a considerable proportion of the bulk of the fruit, and its reduction is to be desired. As pointed out by Rolfs, it is important that the seed should fill the cavity, as otherwise the movement of the seed during shipment damages the pulp.

Modern discoveries in evolution and plant breeding make it evident that the character of seedlessness in a fruit, though rarely secured, may be sought in either of two ways: (1) If the plant is normally open fertilized, self-fertilization and selection for a number of generations will in many cases produce sterility, and consequently seedlessness. (2) By artificially pollinating the flowers with pollen from a variety or species so far removed that the fertilization is imperfect, the exocarp or other parts of the fruit that are entirely the product of the female parent may develop, while the seed, which is the result of the union of the male and female elements, remains small or is aborted entirely.

As the avocado is open fertilized, the first method mentioned is perhaps more simple, but will take more time, and this is, of course, a great disadvantage with fruits that are so long in coming to bearing.

The second method necessitates sufficient skill to effect hybridization, and this of the most difficult kind, but has the advantage of securing much quicker returns.

The element of time is of so much importance that, if possible, all methods should be tried simultaneously.

Rolfs[a] states that a seedless avocado has been discovered in Florida, but does not say whether the fruit is otherwise desirable or not.

[a] Bul. 61, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1904.

TEXTURE.

The fine, creamy texture of the avocado plays an important part in winning admirers of this fruit. If free from fiber, the texture is usually not unlike that of very soft cheese. Lack of uniformity is the greatest danger, for if the flesh is uniform and free from fiber it leaves little to be desired. The manner in which the fruit is ripened probably has more to do with the uniformity and nature of the texture than does the variety. Poorly formed fruit, or fruit that has been picked too green, will often have the flesh soft and discolored in some places, usually near the skin, while the remainder is hard and unripe. Careless packing, so that the fruit is subjected to pressure at some point, will also bring about this undesirable condition. For shipping, the fruit must, of course, be picked green, and to insure uniformity in ripening it must be packed with the greatest care.

FLAVOR.

So far as observed, the most delicious and highly flavored avocados are some of the small, thick-skinned, and thin-fleshed forms of southern Mexico and Central America. The advantage, however, is slight, there being much more uniformity in the flavor of the different forms of the avocado than in most fruits. A really poor or disagreeable flavor has never been noted, except, perhaps, in cases where the fruit ripened unevenly, and then it is usually due to the part eaten being either green or overripe. Improvement in this character might slowly be brought about by selection, or perhaps by crossing with some of the small and more highly flavored forms.

YIELD.

Avocados have been subjected to careful cultivation for such a short time that little is known concerning the conditions that influence yield. As with most tropical plants, climate has probably a greater influence than soil, and judging from the fact that in nature the trees frequently drop their leaves before the fruit matures, it may be expected that a rather decided alternation of wet and dry seasons is an essential.

In Hawaii it appears that several fruits in the same cluster mature. This has never been observed in Central America or the West Indies, where large numbers of the fruits set, but all but one of each cluster drop while still young.

If commercial fertilizers are applied, it would seem that the proper time is immediately after the young fruits have set.

SIZE.

The largest avocados that have come to our immediate notice are those in Porto Rico. (Pl. II.) Travelers in Colombia, however, report much larger fruit, and both Hawaii and Florida probably produce fruit as large or larger than any in Porto Rico. Large size in the avocado is not such a prime essential as with many fruits. Even a medium-sized fruit is usually large enough for two people, and large samples might with a certain class of buyers be less desirable. Of course, this should not be taken to mean that a tree that bears large fruit is less desirable than one that bears small fruit, but only that it might not be well to go to much trouble or expense to secure varieties that excel only in size. With improved cultivation the size of the fruit will doubtless be increased to some extent without the introduction of new forms.

RESISTANCE TO COLD.

An avocado able to withstand slight frosts would place the industry in Florida and California on a much more secure footing. Forms having this quality are likely to be found in the highlands of Central America and Mexico. A form from Monterey that withstands light frosts has already been introduced into California and Florida. With this form the blossoming season is so early that in California the cold weather frequently destroys the crop. The importance of more hardy forms is apparent from the statement of certain California growers that if relieved of the danger and loss from frosts the avocado would be the most profitable fruit to grow, there being a ready market and good prices.

DISEASES.

The only diseases of the avocado thus far reported are those mentioned by Rolfs[a] as occurring in Florida. Similar diseases doubtless exist in other localities and will be reported as soon as the culture receives the same attention that has been given it in Florida.

Trees of the round thick-skinned form growing in Guatemala were found to have their leaves badly infested with galls and also were eaten by a caterpillar. Apparently the same galls were here found growing on the wild relative of the avocado—the "coyo."

D. L. Van Dine[b] figures an avocado leaf infested with mealy bug. So far as known the flesh of the fruit is never troubled with insect

[a] Bul. 61, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1904.

[b] Insecticides for Use in Hawaii, Bul. 3, Hawaii Agricultural Experiment Station, 1903.

pests, a remarkable fact if true, for the flesh would seem to form an ideal medium for their depredations.

The seeds of some of the smallest forms in the City of Mexico were found infested with the larvæ of an insect, and at Tapachula, Mexico, the cotyledons frequently showed large, black excrescences, the nature of which could not be determined. Neither of these troubles appeared to injure the fresh fruit, but if the fruit was kept for any length of time they might become sources of decay.

In Jamaica a fungous disease that affects coffee trees is said to be definitely associated with the roots of dying avocado trees. It is described in the following extract:[a]

> A coffee planter suffered serious losses from the sudden dying out of trees on certain fields. As guano had been employed as a fertilizer on these lands some years before, the planter attributed the mischief to the fertilizer.
>
> On visiting the cultivation, I found that the damage was caused by a root fungus and that there was a definite connection between the roots of dying or dead avocado pear trees and the affected coffee. Microscopic examination confirmed this view. I have examined similar samples from other parts of the island which confirm the view that the pear should not be grown on any lands intended for subsequent cultivation.

THE AVOCADO IN PORTO RICO.

With the possible exception of the pineapple, the avocado is perhaps the only fruit which Porto Rico is at present producing of sufficiently high quality to enable it to compete successfully with the fruits furnished by the more highly developed tropical regions. The quantity is also sufficient, although the season is at present short, to warrant the opening of a trade with the United States.

First among the difficulties is the fact, already noted, that the public is at present little acquainted with this rather unusual form of fruit. There is, however, already demand enough to show that it is likely to suit the American taste. Again, the fruit reaches our public in such small quantities that few have a chance to test it.

That Porto Rico does not participate in the small consignments that are now received in the United States is largely owing to the difficulty in shipping the fruit so that it will reach its destination in a marketable condition. With the varieties now in Porto Rico it seems doubtful whether this can be done except by shipment in cold storage. There are numerous other difficulties with the present conditions which would have to be taken into account before success can be assured. The trees, though numerous in the aggregate, are so scattered—there being no plantations—that it is difficult to secure anything like uniformity in the shipments. The natives allow the

[a] H. H. Cousins, June 23, 1904, Supplement to Jamaica Gazette, 194.

fruit to become nearly ripe before it is gathered, in which condition it will probably not ship well even in cold storage. The fruit is not carefully gathered, but is knocked off the trees, a method which completely destroys the keeping qualities of the varieties now growing in Porto Rico.

The shortness of the season is another obstacle in the way of making the shipping profitable. This can probably be lengthened to a considerable extent by the introduction of new varieties and the proper selection of the localities where the fruit is grown. Shipments made from Porto Rico would, however, fare much better if they could be supplemented by shipments from other countries in which the fruit ripens at a different season. Porto Rico, Mexico, Central America, Hawaii, Florida, and California can probably supply the United States with avocados throughout the entire year.

By placing the fruit in cold storage it would doubtless reach New York in a salable condition. This would be, however, a continuous expense, even if it were found that the fruit was uninjured, and a variety that will ship at ordinary temperatures would have decided advantages. That such varieties exist is demonstrated by the successful shipment of Cuban fruit. It is furthermore believed that the thick-skinned varieties of Guatemala will prove even better keepers than those of Cuba.

In establishing the industry in Porto Rico the first step is, consequently, the introduction of better shipping varieties.

THE AVOCADO IN HAWAII.

Very fine avocados are grown in the Hawaiian Islands, particularly on Oahu, in the vicinity of Honolulu.

The chief difficulty here is the danger from high winds, confining the industry to sheltered localities.

Prices in Hawaii are high in comparison with most regions where the fruit is grown, and San Francisco affords a ready market. On page 40 is a short account of an experimental shipment in cold storage, showing that by this means the fruit can be shipped not only to San Francisco, but to points as distant as New York.

THE AVOCADO IN FLORIDA.

The culture and propagation of the avocado have recently received greater attention in Florida than in any other locality. A special bulletin on the subject by Mr. P. H. Rolfs, pathologist in charge of the Subtropical Laboratory at Miami,[a] gives the status of the culture in that region, together with directions for cultivation, asexual methods of propagation, descriptions of forms, etc.

[a] Bul. 61, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1904.

In spite of the fact that nearly all of the avocados north of the southern end of Merritts Island were killed to the ground by the freeze of 1894–95, showing the avocado to be no more hardy than the mango, planters have been by no means discouraged. Orchards of considerable size exist and the asexual propagation of the better forms is being rapidly pushed. There seem, however, to be but two, or possibly three, well-marked types in Florida, and the chances of securing desirable varieties for asexual propagation might be greatly increased by the introduction of some of the better forms from Central and South America. In Florida the shipping quality of the fruit is not of such prime importance as in Porto Rico, and consequently the choice of varieties should differ in the two localities.

THE AVOCADO IN CALIFORNIA.

The growing of avocados in California is at present restricted to the very limited frost-free areas. In many localities where the frosts are very light they would do little or no damage did they not occur at the time of blossoming, thus destroying the crop.

A slightly later flowering variety would avoid this and considerably extend the range of culture.

There is a good local market for avocados in California, prices being fully as high and the fruit as popular in San Francisco as in the eastern cities.

BEARING AGE AND LIFE OF TREE.

In favorable localities avocado trees will come into bearing about the fourth year from the seed. In more températe regions, like southern Europe, it requires six or seven years. Budded or grafted trees should come into bearing somewhat earlier. If the tree makes a good growth, the yield should continue to increase until the tenth or twelfth year.

The next point to be considered is the probable life of the tree. Ramon de la Sagra gives this as about 80 years. This is probably not a high estimate, for very old trees are common in most tropical countries. In the opinion of Mr. Henry Davis[a] trees are still growing in the northern part of Peru which antedate the advent of the Spanish settlers. Some of these trees are fully three feet in diameter. Neither do old trees appear to become less productive.

YIELD.

The yield of an avocado tree when in full bearing is quoted as ranging from 50 to 500 fruits. In Hawaii the yield is said to be from 50 to 250 fruits, being larger in alternate years. There is an actual

[a] Hawaiian Forester and Agriculturist, 2: 66, 1905.

record of a tree in California that yielded 500 fruits in its eighteenth year. In Porto Rico, while none were actually counted, the average yield of a full-grown tree would surely seem to be above 100.

Rolfs states that the yield is usually overestimated owing to the fact that trees with few or no fruits are overlooked. An orchard of 110 trees of bearing age, near Buenavista, Fla., was found in 1903 to yield an average of only 10 fruits per tree. The most prolific tree bore 385 fruits.

HARVESTING.

TIME TO PICK.

The degree of maturity which the fruit should attain before it is picked depends, of course, on the length of time it must be kept. There is, however, no evidence that the quality is improved by fully ripening on the trees, and in countries where the fruit is gathered for local consumption it is customary to pick and store it several days before eating.

In most varieties when the fruit is fully ripe the seed does not entirely fill the central cavity, but whether it should reach this stage before picking has not been definitely determined.

This failure of the seed to fill the cavity is probably due to a slight shrinking of the flesh, the result, possibly, of evaporation after the fruit has ceased to receive nourishment from the tree. The beginning of this process would seem to indicate the maturity of the fruit. In the absence of definite information it seems probable that the best results will be obtained with fruit picked when fully grown, but before it has begun to ripen. Dybowski [a] recommends that the red varieties be picked as soon as they begin to color and the green ones when the color begins to become lighter. Many of the green varieties, however, do not change color appreciably on ripening.

METHOD OF GATHERING.

The picking of the fruit, although a matter of prime importance, is one that has been given no consideration. In Florida, where the avocado has received the most careful attention, the trees seldom reach a height at which it is impracticable to use stepladders, but in the Tropics, if the trees are at all luxuriant, they place most of the fruit entirely beyond this method of access. In these countries the fruit is usually knocked from the trees with long poles or the tree is climbed and the fruit shaken to the ground, which, of course, ruins its keeping qualities and causes it to ripen unevenly.

[a] Traité Pratique des Cultures Tropicales, 451, 1902.

Until some satisfactory method is devised for gathering the fruit without bruising and with the stems attached, the shipping qualities of the fruit from tall trees are likely to prove unsatisfactory.

The wood of the avocado tree is so brittle as to make the use of ladders impracticable, and this, together with the fact that the fruit is borne far out on the ends of the branches, also makes it impossible to gather the fruit by climbing the trees.

It would seem that the most feasible method of gathering avocados would be the using of some form of mechanical fruit picker, mounted on a slender pole. Numerous styles of this implement are to be found on the market, but perhaps none will answer the purpose without alteration.

The fruit picker that seems best adapted is one that has a cloth tube along the side of the pole into the upper end of which the fruit drops and down which it slides into a basket attached to the waist of the operator. Most of the pickers of this type, however, have merely claws to pull the fruit from the trees, and it may be necessary to combine this cloth tube with one of the long pruning instruments that are on the market, that the fruit may be cut and not pulled from the trees.

Fruit pickers so constructed as to pick the fruit by cutting the stem are on the market, but these for the most part catch the fruit in a little basket or bag at the end of the pole and necessitate the lowering of the picker from the tree after two or three fruits are picked, whereas the arrangement first described need not be lowered.

C. Riviere[a] calls attention to the fact that the avocados common on the south side of the Mediterranean and in Madeira and the Canary Islands are very short stemmed or sessile, whereas the American forms, so far as known, all have comparatively long stems, though varying greatly in this regard. The writer also calls attention to the fact that the long-stemmed forms are more desirable, it being difficult to pick those that are nearly sessile without pulling the fruit from the stem and thus injuring the keeping qualities of the fruit.

PACKING AND SHIPPING.

The lack of good shipping qualities in the avocado is probably the most serious obstacle to the rapid development of the industry in the West Indies and is certainly the chief reason why Porto Rico does not participate in the small shipments that are now made to New York. That it is possible without cold storage to ship avocados from Cuba, while all experiments with the Porto Rican fruit have proved failures, makes it evident that a study of the causes of this

[a] Journal d'Agriculture Tropicale, 222, July, 1904.

difference is of prime importance. It is believed that the better keeping and shipping qualities of the Cuban avocados are due to the characteristics of the fruit rather than to differences in gathering or packing. Indeed, this might be inferred from the appearance of the fruit, that of Cuba having a thicker and harder skin than the Porto Rican forms. The introduction of the thick-skinned varieties from Guatemala should give Porto Rico a decided advantage, for it is believed that the Guatemalan forms will prove even better shippers than those of Cuba.

Though avocados are successfully shipped from Cuba, Florida, Mexico, and other places to northern cities, and many different styles of packing are employed, little can be learned from these experiments as to the best method, since no account is taken of the variety of the fruit, which is undoubtedly a more important factor than the method of packing. That avocados from Cuba, wrapped in newspaper and packed in large crates, have come through in better shape than those from Porto Rico, wrapped in tissue paper and packed in crates only one layer deep, does not necessarily indicate that the former method of packing was superior, but it may mean that the Cuban fruit was such a good shipper that it kept in spite of the inferior method of packing.

From a comparison of the different methods of packing that are practiced, taking into consideration as far as possible the nature of the fruit, it seems, however, that the avocado, like most tropical fruits, keeps best when packed in such a manner as to be protected from jars or any undue pressure and in such a way that the fruit is well ventilated. Another important consideration with the thin-skinned forms is that they be packed so that the individual fruits do not come in contact with each other, for, even with the greatest care, bruised fruits will frequently be included. These will rapidly decay, and if not isolated will induce decay in those with which they come in contact. This danger is much less with the thick-skinned forms.

These conditions are very satisfactorily met by packing the fruits in fine excelsior or some similar substance in rather open cases that are not so large as to prevent those on the inside from being ventilated. If the fruits be wrapped, it should be with some porous paper, but where they are separated from each other this precaution would seem unnecessary or even detrimental.

The amount of ventilation the fruit should receive undoubtedly depends on the variety and still more directly on the temperature, fruit in cold storage requiring little or no ventilation.

The best results in the shipments to New York of avocados from Cuba have been obtained with the fruit wrapped in newspaper and

packed in open crates but one layer deep. Tissue paper was tried, but it was said not to offer sufficient support and did not prove as satisfactory as the newspaper.

Florida growers report that they experience no difficulty in packing their fruit so that it reaches the northern market in good condition. The more careful shippers, however, pack the wrapped fruit in excelsior.

The few experiments that have been tried in shipping Porto Rican avocados, other than in cold storage, have, so far as can be learned, resulted in every case in almost complete failure. Little could be learned as to the methods of packing that were employed. In one case, however, the fruit after being wrapped in tissue paper was again wrapped in oiled paper. In this instance the fruit was practically all rotten when it reached New York. It seems more than probable that the fruit would have shipped better without the oiled paper, as this packing would very effectually prevent all ventilation, a necessity at all ordinary temperatures. A very important consideration in the keeping qualities of fruit, brought to the writer's attention by Mr. William A. Taylor, of the Department of Agriculture, is the climatic conditions that prevail at the time the fruit is packed. Fruit packed in a dry climate has been found to keep much better than the same fruit packed when the atmosphere is moist. This is doubtless true of the avocado and may explain the successful shipment from southern Mexico to New York of varieties that appear to differ but slightly from those of Porto Rico.

COLD STORAGE.

In cooperation with Mr. William A. Taylor, pomologist in charge of field investigations, and Mr. Jared G. Smith, director of the Hawaii Agricultural Experiment Station, an experiment was tried of shipping avocados in cold storage from Hawaii to New York City.

Five crates of avocados were packed and shipped in cold storage from Honolulu about September 25, reaching San Francisco on October 4. From San Francisco they were expressed to Lodi, Cal., and during this transfer they were exposed to air temperatures for from six to eight hours. At Lodi they were again placed in iced cars and sent directly to New York City, where they arrived on October 20. The fruit was consigned to Messrs. Lane and Son, who forwarded samples to Washington. It will thus be seen that the fruit was thirty days in transit. Although the majority of the samples were found to have suffered from the long trip, some of the lots were in good condition, thus demonstrating that, with a knowledge of how to handle the fruit, even the more delicate forms can be successfully

shipped in cold storage, provided the fruit is not more than three or four weeks in transit.

That this experimental shipment was hardly a fair test is shown by the statements of Mr. J. E. Higgins, who superintended the shipping of the fruit at Honolulu. In a letter to Mr. Taylor he says:

> Most of the pears were by no means representative. The pear season was about over when we learned from you that there was an opportunity to make the experimental shipment. The fruits were inferior in size, only those marked F 13 being first-class specimens in this respect. It being the end of the season, the fruits, though hard, were of course quite fully matured. The fruit was picked several days before the sailing of the steamer and was held in cold storage until it could be received at the ship.

Shipments of avocados, made at air temperatures, are frequently placed in cold storage as soon as they reach New York. This process is resorted to in the effort to hold the fruit for the fall trade, and, even though the loss be heavy, the increased price still makes it a profitable procedure. There is a very uncertain element involved in this, for with fruit that appears uniform when placed in cold storage some comes out in perfectly sound condition, while the remainder will be completely decayed. This lack of uniformity in the keeping qualities is probably due to the different degrees of maturity at which the fruit is picked and to the conditions to which it has been subjected in transit, it being very difficult to detect such differences from the outward appearance of the fruit.

As to the best temperature, amount of ventilation, method of packing, etc., little is known. Dybowski[a] states that shipments have been made in cold storage from the Antilles to France, and that a temperature of 2° C. (35.5° F.) was found the most satisfactory. He recommends that the fruit be wrapped in paper and packed in excelsior. Shipments made in this way are said to reach France in good condition.

MARKETING.

The market for avocados is at present a limited one, the fruit being still somewhat of a novelty. It is, however, steadily increasing and from present indications will keep pace with the supply. The fruit is already fashionable, and if uniformity in the supply both as regards quantity and quality could be secured and the prices somewhat reduced, as could well be the case were large quantities of the fruit handled, its popularity would rapidly increase.

Lack of classification is perhaps the greatest hindrance to the development of a regular market. Fruits more widely different than "Ben Davis" and "Northern Spy" apples are all classed as avocados without further distinction. This lack of classification is accom-

[a] Traité Pratique des Cultures Tropicales, 450, 1902.

panied with a corresponding lack of uniformity and must seriously hinder the growth of the trade. Not only may two shipments of avocados be totally unlike, but the individual shipments often contain distinct forms of a widely different character. Plates VI and VII show two samples from the same box. These fruits, so distinct in form, were no less different in flavor, and both were very inferior. The size and external appearance, as well as the price (35 cents apiece), would lead one to expect that he was purchasing fair specimens of the fruit, but if an opinion was formed from such specimens as these it could hardly be other than that the fruit was insipid and in no way worth the price asked.

In sections where the fruit is unknown a demand is more rapidly created by inducing hotels, clubs, etc., to include this article in their menus than by merely exhibiting the fruit in the markets, for while many might be led to purchase samples of this strange fruit if seen in the market, they would frequently be ignorant of its use as a salad, in which case they would probably pronounce it insipid and might be deterred from further trials. On the contrary, anyone tasting for the first time the prepared salad would usually be pleased and would be likely to investigate the source of the new dish.

In Washington this fruit has sufficient admirers to warrant the frequent insertion of a notice in the papers, by dealers, to the effect that a shipment of avocados is on hand. The shipments, though small, are fairly regular, and there are one or two places where the fruit can usually be found during the season.

In the present state of the market there is nothing like a fixed price for avocados. In New York and Washington the usual retail price may be said to be about 25 cents for good fruit; 60 cents is, however, frequently asked for fine fruit, and fair specimens can sometimes be purchased as low as 10 cents. This low figure is, however, never reached except in cases where large shipments have failed to be disposed of and the fruit is in serious danger of spoiling.

With reference to the San Francisco market, Alexander Craw states:[a]

> Sound "avocado pears" always meet with a ready market in San Francisco, and at good prices, at times ranging from $2 to $5 per dozen, retail, for good fruit. Occasionally there is a heavy drop, owing to the arrival of overripe or badly packed fruit. In selecting avocado pears for distant markets see that they are as nearly full grown as possible, but hard. On no account should the fruit be plucked from the tree, but clipped with pruning shears, leaving but a very short portion of the stem—not over half an inch in length. On no account must any leaves be packed with the fruit, or the horticultural quarantine officers of the Pacific ports will demand the unpacking of such consignments, as occasionally a few scales are found on the foliage, but not on the fruit.

[a] Hawaiian Forester and Agriculturist, 2: 67, 1902.

The following, taken from the Crop Reporter of the Department of Agriculture, January, 1903, gives some indication of the prices in England:

With regard to the newer fruits which are attracting attention in the English markets, there are several which call for special reference. Among such are the avocado pears. These pears are high priced, selling from 1s. to 1s. 3d. (24 to 30 cents) each, retail.

MARKET SEASON.

The regular season for avocados is in the summer and the early autumn, the bulk of the fruit being received during the months of August and September. This is the most unfavorable time for a tropical fruit of this kind to be placed on the market, for not only does it come in competition with the fall fruits, but at this time large numbers of the admirers of this fruit are away from the cities at summer resorts, and in order to reach the best class of customers the fruit must be reshipped. This feature of the trade is so important that commission merchants can afford to hold the fruit in cold storage for this class of customers until they return to the cities, and this in spite of the fact that the fruit reaches them in such an advanced stage that but a very small percentage is salable when taken from cold storage. In cities like New York, the Cuban and Spanish populations are always ready to purchase avocados, but this class will buy only at a comparatively low price, which under present conditions serves merely to protect the merchants from total loss. Florida growers say that for fruit that they can hold until the latter part of September or into October they can ask their own price. It will thus be seen that it is of the greatest importance to secure late-maturing sorts.

With the improvement of transportation facilities and good shipping varieties the northern markets can probably be supplied with avocados every month in the year. In fact, February is probably the only month during which no avocados are received in New York. Outside of the regular season, however, the shipments consist of a few fruits brought in the ships' ice boxes. Of these, the earliest are said to come from Colombia and the latest from Santo Domingo. A possible schedule would be as follows: Florida, Porto Rico, and Cuba, June to November; Hawaii, September to December; Mexico, December to March; Central America, March to June. To dealers familiar only with the West Indian type of fruit the shipping of avocados from such distant points as Central America will seem entirely impracticable. The keeping qualities of the thick-skinned forms of Central America make this, however, not at all impossible provided the picking, packing, and shipping be handled in an intelligent manner. Indeed, small shipments have already been made from the City of Mexico to New York via Los Angeles, where the fruit was repacked, and this with a comparatively thin-skinned variety.

Viewed from the standpoint of the producer, however, the question is not how can the market be supplied throughout the entire year, but how can avocados be produced in our own possessions at a time to command the best prices. Too great confidence should not be placed in the introduction of early or late fruiting varieties from other countries, for the season of fruiting is to a great extent the result of climatic conditions, and an early fruiting form in Guatemala if transferred to Porto Rico might soon become no earlier than the native kinds. In a general way the fruiting season is found to be about the beginning of the rains. In Porto Rico different parts of the island exhibit considerable disparity as to the time that the rains begin, and by carefully selecting localities with this in mind the season might be materially extended. Selection for this character would probably be well repaid, as it has been with so many other fruits, but unless asexual methods of propagation are practiced, too much confidence should not be placed in the ability to hold this or any other character obtained through close selection. In localities with comparatively uniform climatic conditions the growing of avocados under irrigation might have important advantages, for if any method of artificially inducing the plants to bear should be successful it would be possible to control the season by checking growth at the proper time.

METHODS OF EATING.

By far the most common method of eating the avocado is in the form of a salad. As such it is eaten raw with a great variety of dressings and condiments. Few salads are so easily prepared as the avocado. Usually the fruit is simply cut in half by passing a knife through the skin and flesh until it comes in contact with the seed. It will then separate into two cups, forming convenient receptacles for the seasoning, which is added a little at a time to suit the taste, and the flesh is scooped from the inside of the cup with a spoon. One half of the fruit is usually sufficient for a person at a meal. The most common dressing is salt, pepper, and vinegar. Oil is often added, but unless the oil and vinegar are beaten into a mayonnaise this would seem superfluous, as the fruit is itself very oily. Lime or lemon juice is often substituted for vinegar.

While the novice usually considers some form of acid necessary to add piquancy, those better acquainted with the fruit frequently eat it with salt alone, and many think that even salt tends to mask the delicious nutty flavor, and prefer it in its natural state without any seasoning whatever. There are a few people, probably of New England origin, who eat the fruit with sugar and vinegar, and some even profess a fondness for it with a dressing of sugar and cream.

If it be desired to more thoroughly incorporate the dressing the

flesh can be removed from the skin and, after mixing the whole, can be returned to the skins for convenience in serving. This is more neatly accomplished with the thicker skinned forms.

In Guatemala, Porto Rico, parts of Mexico, and doubtless elsewhere, the avocado is sliced raw and added to soups. Even a small piece of the soft pulp crushed in a plate of soup imparts a delicate flavor, and during the season of avocados the baskets of people returning from market are seldom without specimens of this fruit. In the market at Cordova the little piles laid out for individual purchasers consisted of three or four little fruits no larger than walnuts, with flesh not more than one-fourth of an inch thick. As better fruit was not to be had, even these met with ready sale, so indispensable is this article of diet considered.

In French countries the avocado is customarily served as an "hors d'œuvre." E. Roul states [a] that an exquisite dessert is made by covering the fruit with a dressing of cherry brandy, sugar, and cream beaten almost to an emulsion.

In St. Thomas the fruit is eaten with Port or Madeira wine and lemon or orange juice.

In Brazil the fruit is made into a sort of custard pudding.

The following methods of preparing the fruit, as well as that for extracting the oil, were kindly furnished by Mrs. William Owen, of Sepacuite, Guatemala:

No. 1.—Divide in half and serve in the shell, as many prefer them without the addition of salt.

No. 2.—Cut the meat into cubes, mix with sufficient mayonnaise to coat it well, put in a platter, pile high in the center, and sprinkle over hard-boiled egg chopped fine.

No. 3.—Divide in half and carefully remove the meat. Add the yolk of a hard-boiled egg and one tablespoonful of French dressing for each fruit. Press through a sieve and pile in the half shells. Garnish the tops with the white of the eggs chopped fine, a sprig of parsley, and one small red pepper.

Sandwiches.—Use thin slices of bread buttered thinly; spread on a paste prepared of mashed avocado mixed with a dressing of oil, salt, tarragon vinegar, and a little nutmeg.

Avocado oil.—Divide the fruit in half and remove the seed. Place the two halves together again and lay them in a large basket. Cover with a cloth and keep in a cool, dark place until the meat turns black; then put them into a coarse cotton bag. Sew up well and put into a press. The oil is very clear, and all the Ladinos say it will never become rancid. They never use it in cooking, though it has a pleasant flavor, but say it is fine for the hair.

The following method of preparing a salad with avocados is given by Janet M. Hill: [b]

Cut three ripe aguacates in halves, take out the stone or seed, and scoop the pulp from the skin. Add three tomatoes, first removing the skin and core, and

[a] Sagot, Manuel Pratique des Cultures Tropicales, 197, 1893.

[b] The Cooking School Magazine, 9: 153, Oct., 1904.

half a green pepper pod cut in fine shreds. Crush and pound the whole to a smooth mixture, then drain off the liquid. To the pulp add a teaspoonful or more of onion juice, a generous teaspoonful of salt, and about a tablespoonful of lemon juice or vinegar. Mix thoroughly and serve at once. This salad may be served at breakfast, luncheon, or dinner.

In a report of Mr. John R. Jackson [a] it is stated that "it is either cooked or served as a vegetable with white sauce," as well as eaten as a salad. This is the first account noted of cooking the avocado.

FOOD VALUE.

The results of the chemical analyses given below show the comparative value of the avocado for food purposes. For the following table and the statements concerning it the writer is indebted to Dr. C. F. Langworthy, of the Office of Experiment Stations of the Department of Agriculture.

Analyses of the avocado have been recently made at the Maine and the Florida Agricultural Experiment Stations. [b] The following table shows the results of these analyses and includes, for purposes of comparison, similar data regarding a number of common food products:

Composition of the edible portion of the avocado and other foods.

	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel value per pound.
				Nitrogen-free extract.	Crude fiber.		
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Calories.*
Avocado (analyzed at the Maine station)	81.1	1.0	10.2	6.8		0.9	512
Avocado (analyzed at the Florida station)	72.8	2.2	17.3	4.4	1.9	1.4	854
Pickled ripe olives	65.1	[a]5.7	25.5	3.7		----	1,201
Pickled green olives	78.4	[a]6.9	12.9	1.8		----	680
Apples	84.6	.4	.5	13.0	1.2	.3	290
Bananas	75.3	1.3	.6	21.0	1.0	.8	460
Pears	84.4	.6	.5	11.4	2.7	.4	295
Cocoanuts	14.1	5.7	50.6	27.9		1.7	2,760
Chestnuts, fresh	45.0	6.2	5.4	40.3	1.8	1.3	1,125
Potatoes	78.3	2.2	.1	18.0	.4	1.0	385
Wheat flour	12.0	11.4	1.0	74.8	.3	.5	1,650

[a] Including ash.

In the avocados analyzed at the Maine station the edible portion or pulp constituted on an average 71 per cent of the total weight of the fruit, the seed 20 per cent, and the skin 9 per cent. Prinsen-Geerligs, [c] in an extended study of tropical fruits, reports similar values for the avocado—i. e., flesh 67 per cent, seed 15 per cent, and skin 8 per cent. As the avocado contains about 75 to 80 per cent water and consequently 20 to 25 per cent total nutritive material, it is apparent that it is more directly comparable with succulent fruits

[a] Agricultural News, November 7, 1903.

[b] Maine Expt. Sta. Bul. 75; U. S. Dept. Agr., Farmers' Bul. 169; Florida Expt. Sta. Rpt., 1902.

[c] Chem. Ztg., 21: 719, 1897.

and vegetables than with such foods as bread. As regards the proportion of the water, protein, crude fiber, and ash, the avocado is similar to common fruits like the apple, pear, and banana. In the case of nitrogen-free extract (sugar, starches, etc.) the proportion reported in the avocado was smaller than in the other fruits mentioned. The high percentage of fat in the flesh of the avocado is noteworthy, a large proportion of this constituent in succulent edible fruit being very unusual. In this respect the avocado suggests the olive, which is, of course, very rich in this constituent, the flesh containing, according to recent analyses made at the California experiment station, from 13 to 88 per cent. Generally speaking, a higher percentage of fat is found in nuts and oil-bearing seeds than in succulent fruits, the high fat content being accompanied by a low water content, as in the case of cocoanuts, cited in the table on page 46.

Avocado fat is solid or semiliquid at ordinary temperatures and has been separated, being known as alligator pear oil, Persea fat, and avocado oil. According to Andés,[a] it has at present no commercial importance. Wright and Mitchell[b] state that avocado oil is very similar to laurel butter or bayberry fat, from *Laurus nobilis*, which consists largely of the glycerid of lauric acid, together with a little myristin and other homologues and some olein. Olive oil is quite different in chemical character, consisting of about 25 per cent glycerids of solid saturated fatty acids (palmitic, etc.) and 75 per cent liquid gycerids, mostly olein. Olive oil is known to be a valuable food product and quite thoroughly digested. It is presumable that the avocado fat is also quite thoroughly assimilated, although little can be said definitely concerning its nutritive value, as apparently few, if any, investigations have been reported which bear upon this question.

Prinsen-Geerligs[c] studied the carbohydrate constituents of the avocado and reports 1.72 per cent total sugar, which is made up of 0.4 per cent glucose, 0.46 per cent fructose, and 0.86 per cent saccharose. These figures, taken in connection with the data reported by the Florida experiment station for the total nitrogen-free extract (sugar and starch), would indicate that the starch content is not far from 3 per cent.

Considering all the available data, it seems fair to conclude that the avocado has a fairly high food value as compared with other succulent fruits, especially when its fat content and consequently rather high energy value is considered, closely resembling pickled olives in this respect.

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[a] Vegetable Fats and Oils, 215. London, 1897.

[b] Oils, Fats, Waxes, and Their Manufactured Products, 353. London, 1903.

[c] Loc. cit.

COST OF PRODUCTION.

In calculating the cost of production, the following are the chief factors to be considered: Cost of land, cost of preparing the land, seed and planting, cost of culture, age at which trees bear, life of trees, yield, cost of gathering and marketing the fruit, price and extent of the market.

The cost of land in tropical countries is governed very largely by its position with reference to transportation facilities. In Porto Rico, for example, land located along the main roads and valued at $100 an acre could apparently be duplicated in localities 5 or 10 miles distant for $2 or $3 an acre. Thus, the bulk of a crop and its adaptability to transportation over country roads are very important factors. With avocados at anything like the present prices they would constitute a very concentrated product, probably exceeding coffee in pound for pound value. On the other hand, the fruit must be delayed as little as possible after picking, which, of course, militates against the selection of land too remote from a shipping point.

The cost of preparing the land varies in different localities, but in most countries this item can be estimated with considerable accuracy, as land is usually cleared by measure.

With labor at a reasonable price the seed and planting ought to cost not more than 10 cents per tree, and this with trees 20 feet each way, making 109 to the acre, would aggregate $10.90 an acre. The cost of culture would also vary greatly in different localities, but this again can in each locality be reckoned with considerable accuracy, together with the rebate to be allowed for catch crops.

Where orchards are started from choice varieties by asexual methods of propagation, an additional allowance will have to be made for budding or grafting.

Trees may be expected to come into bearing about the fourth or fifth year and may yield crops for fifty or seventy-five years.

The average yield per tree may be reckoned at 100 fruits, and should come nearer 500.

With a crop of great value like the avocado the cost of gathering and marketing is relatively small, although the fruit must be handled with considerable care, especially the thinner skinned forms.

In the present state of the market the small shipments of avocados that are received usually retail at from 25 to 50 cents apiece.

SUMMARY.

The avocado is a tropical fruit little known in the United States but rapidly growing in popularity. Its appreciation by the northern public is doubtless retarded by a misunderstanding of its true charac-

ter as a food, since it is in reality a salad, being very generally eaten with condiments. This unusual rôle, however, removes it from direct competition with other fruits and tends to make its popularity permanent.

This fruit is undoubtedly of American origin, but appears to have been introduced into the West Indies after their discovery. It was an important article of food among the Indians of the continent from Mexico to Peru. It is not yet certain whether the cultivated trees belong to one or more species, botanical writers having given little attention to the many cultivated sorts. There are many wild species of Persea in this region.

Though few varieties have been described, the diversity of form is very great. In general this diversity seems to follow geographical lines, the forms of any particular region being more or less closely related. A very distinct type, with thick, hard skin, was found in Guatemala, which promises to surpass in shipping qualities the better known forms.

The avocados now found in the markets come largely from Cuba, and the chief commercial difficulty is occasioned by the poor shipping qualities of the fruit and the failure to distinguish the different varieties, the whole industry having suffered from the shortcomings of the poorer forms. Efforts to ship the delicate-skinned Porto Rican fruits have thus far failed. For this island it is recommended that the hard-skinned sorts of Guatemala be introduced. These, it is believed, will stand shipping even better than those from Cuba. Experiments have demonstrated that avocados can be successfully shipped in cold storage.

At present the season for avocados in the markets of the United States is the late summer and early autumn. By importing from different countries, however, the season could be extended throughout the entire year.

The plant requires a strictly tropical climate, with the possible exception of some of the hardy varieties of the Mexican table-lands, and to be prolific there should be a distinct dry season.

Young plants are readily propagated from seed, and budding and grafting can be accomplished, the former method being in common use in Florida.

As far as can be judged from the limited and irregular supply, the market is good, especially in the latter part of the season. Prices range from 10 to 60 cents apiece. Uniformity as regards both quantity and quality is the prime requisite for sustaining the market.

If anything like the present prices can be maintained the growing of avocados of good shipping varieties ought to become a very remunerative industry.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. (*Frontispiece.*) Avocado tree. Freehold, Costa Rica. The broad-leaved type commonly found in the lowlands.

PLATE II. Avocado fruit, Porto Rico. Large, fine flavored fruit; but lacking in shipping qualities. (Natural size.)

PLATE III. Leaf and fruit of avocado, Tapachula, Mexico. "Tapachula," one of the most desirable of the thin-skinned forms, with oval leaves. (Natural size.)

PLATE IV. Avocado fruit, Guatemala City, Guatemala. "Thick-skinned oval," one of the best forms. (Natural size.)

PLATE V. Avocado fruit, Guatemala City, Guatemala. "Thick-skinned round," a very thick-skinned form that will stand rough handling better than those with thin skin. (Natural size.)

PLATE VI. Avocado fruit, Cuba. Purchased in the Washington market October 27, 1902. This and the fruit shown in Plate VII were from the same box and retailed at 35 cents apiece. The fruit had probably been subjected to cold storage. (Natural size.)

PLATE VII. Avocado fruit, Cuba. (Natural size.)

PLATE VIII. Fruit of "Yas" (*Persea frigida?* Linden), San José, Costa Rica. A species of Persea said to withstand frosts. (Natural size.)

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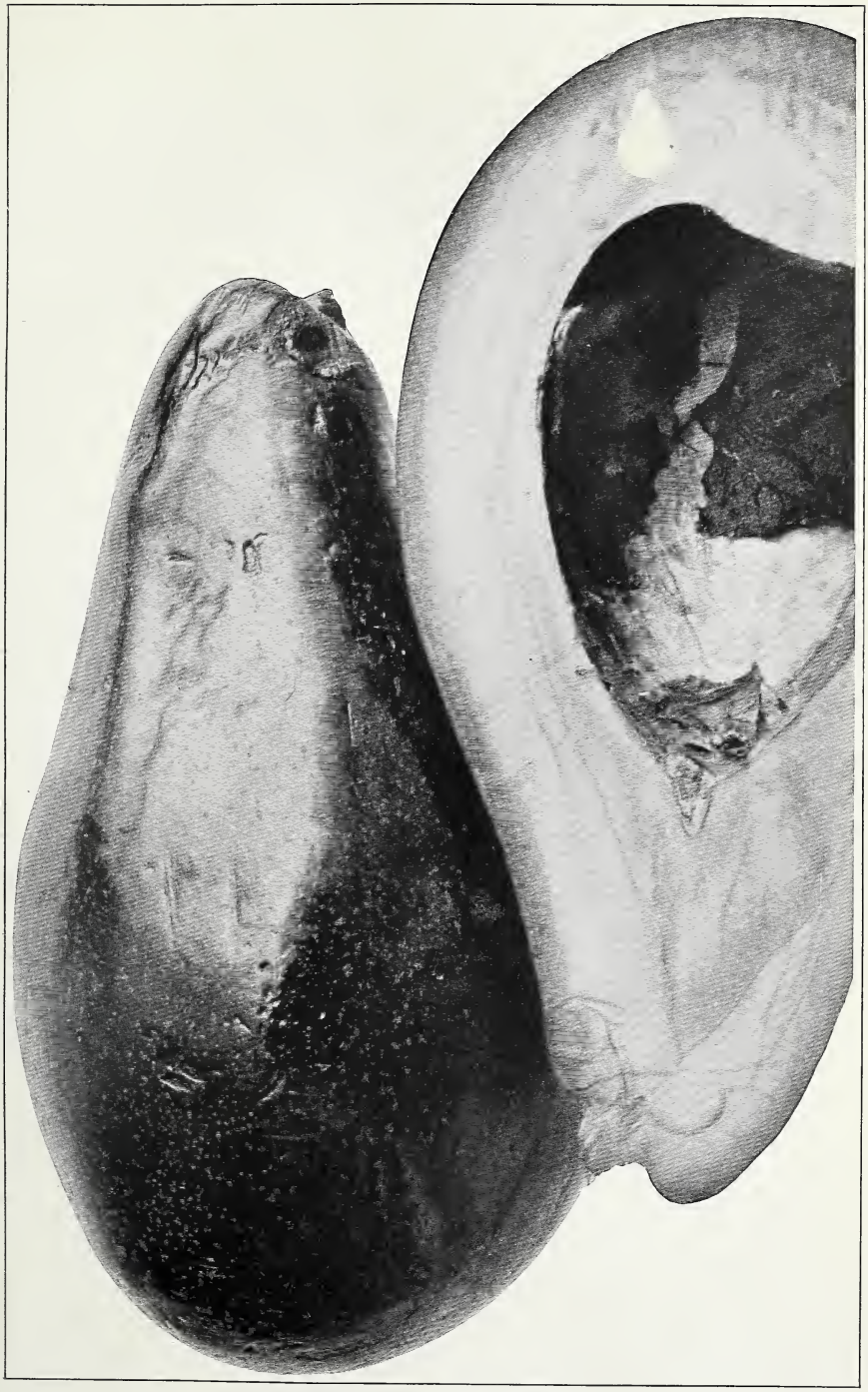
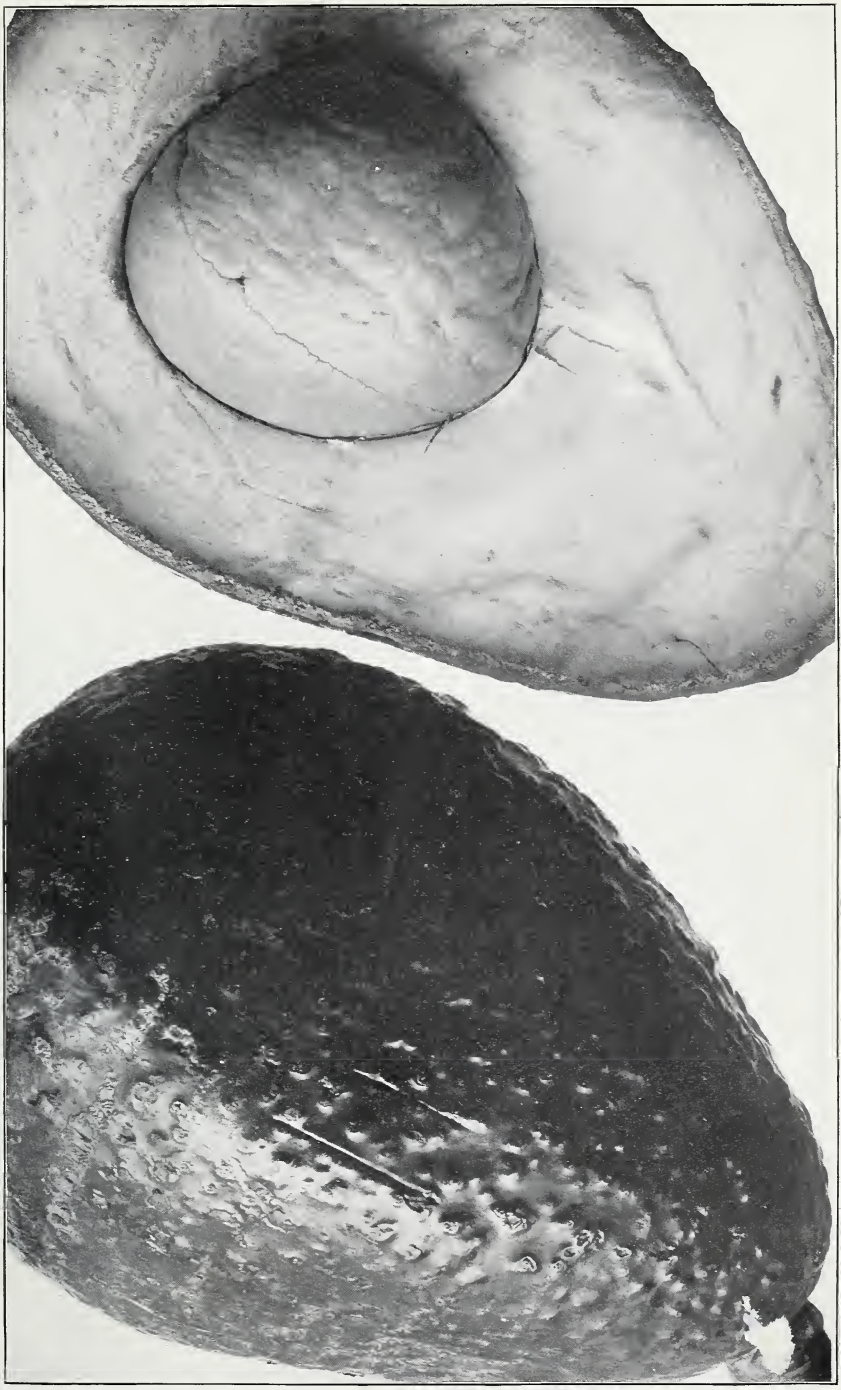


AVOCADO FRUIT, PORTO RICO.

(Natural size.)

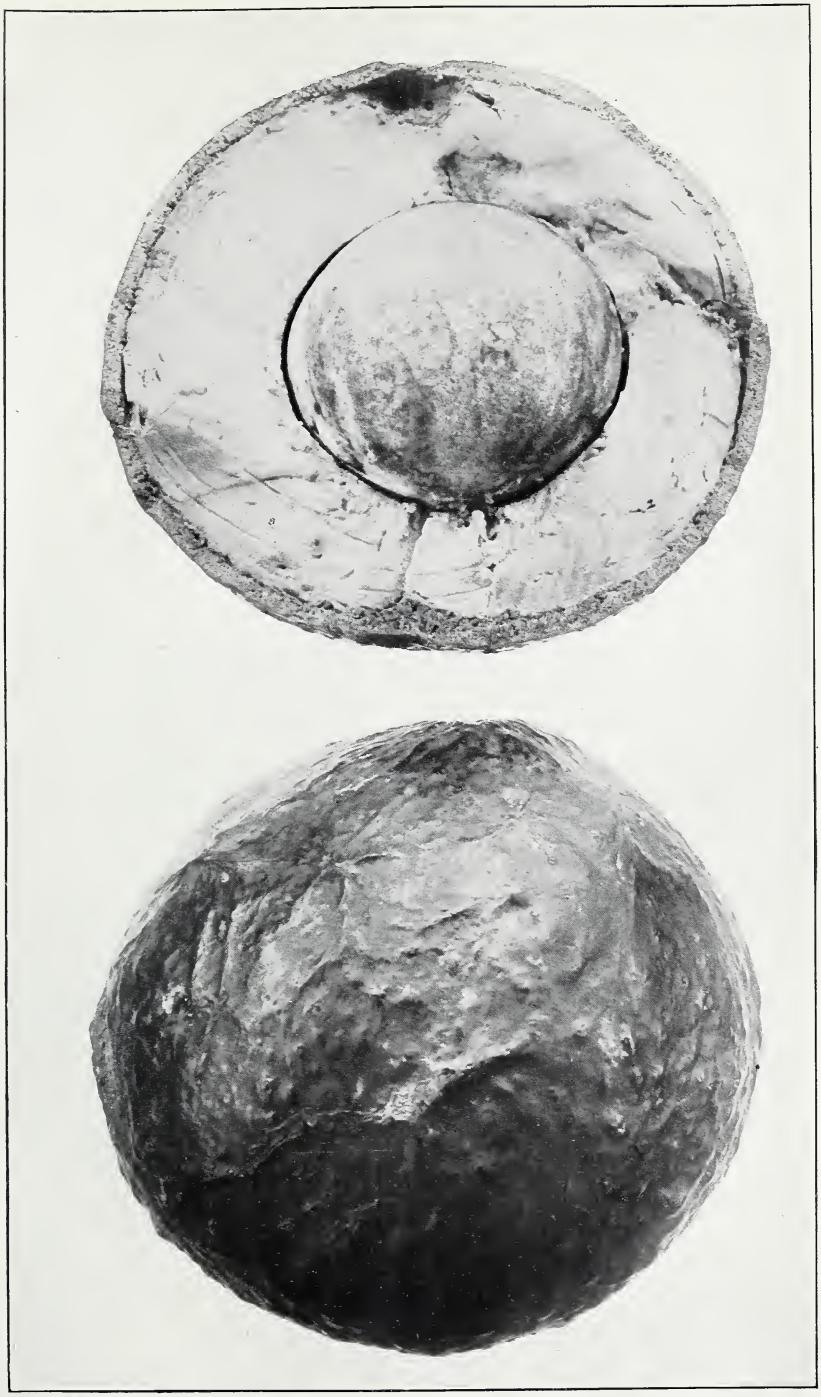
LEAF AND FRUIT OF AVOCADO, TAPACHULA, MEXICO.

(Natural size.)



AVOCADO FRUIT, "THICK-SKINNED OVAL," GUATEMALA CITY, GUATEMALA.

(Natural size)

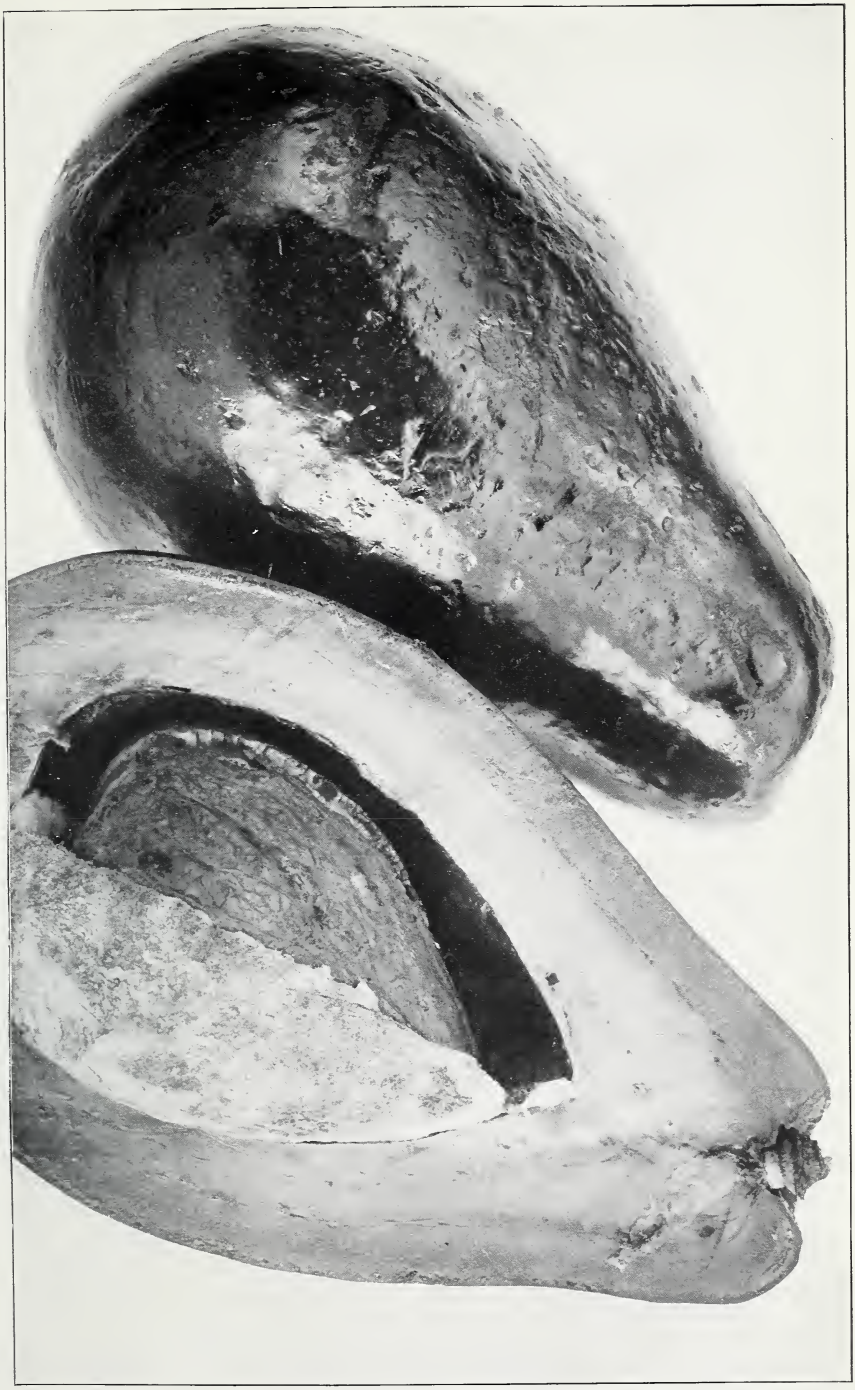


AVOCADO FRUIT, "THICK-SKINNED ROUND," GUATEMALA CITY, GUATEMALA.

(Natural size.)

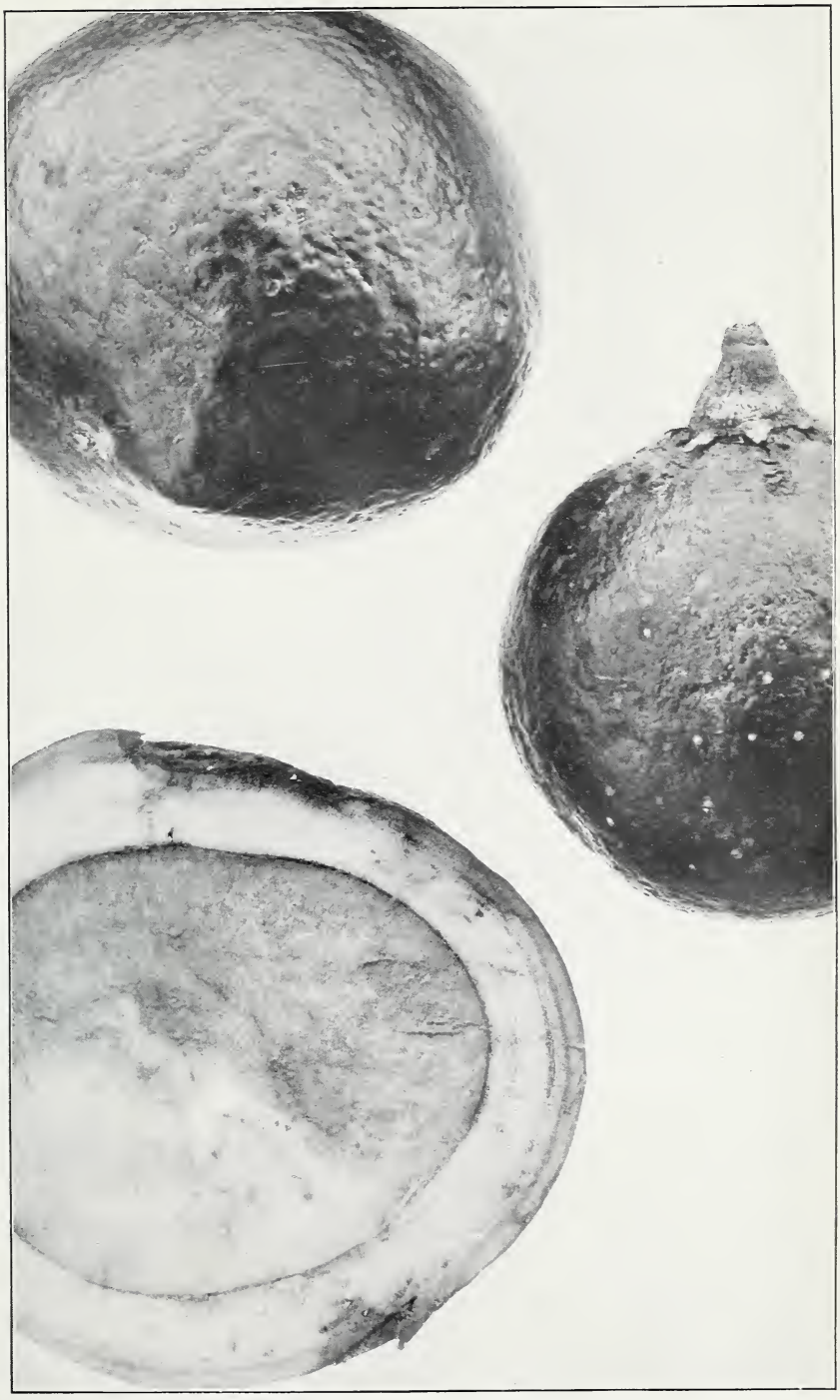
AVOCADO FRUIT, CUBA.

(Natural size.)



AVOCADO FRUIT, CUBA.

(Natural size.)



HARDY AVOCADO, OR "YAS," SAN JOSÉ, COSTA RICA.

(Natural size.)